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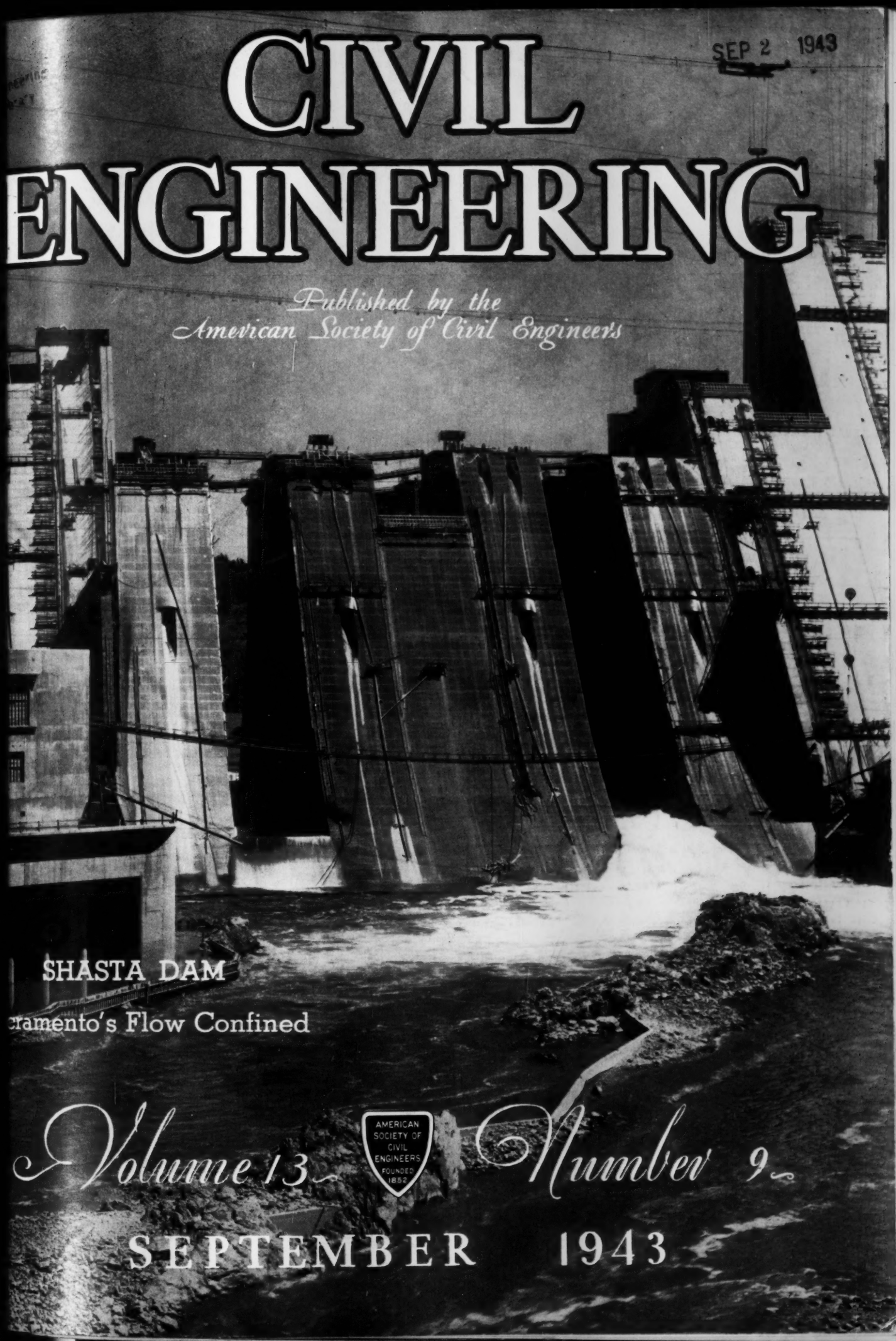

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AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

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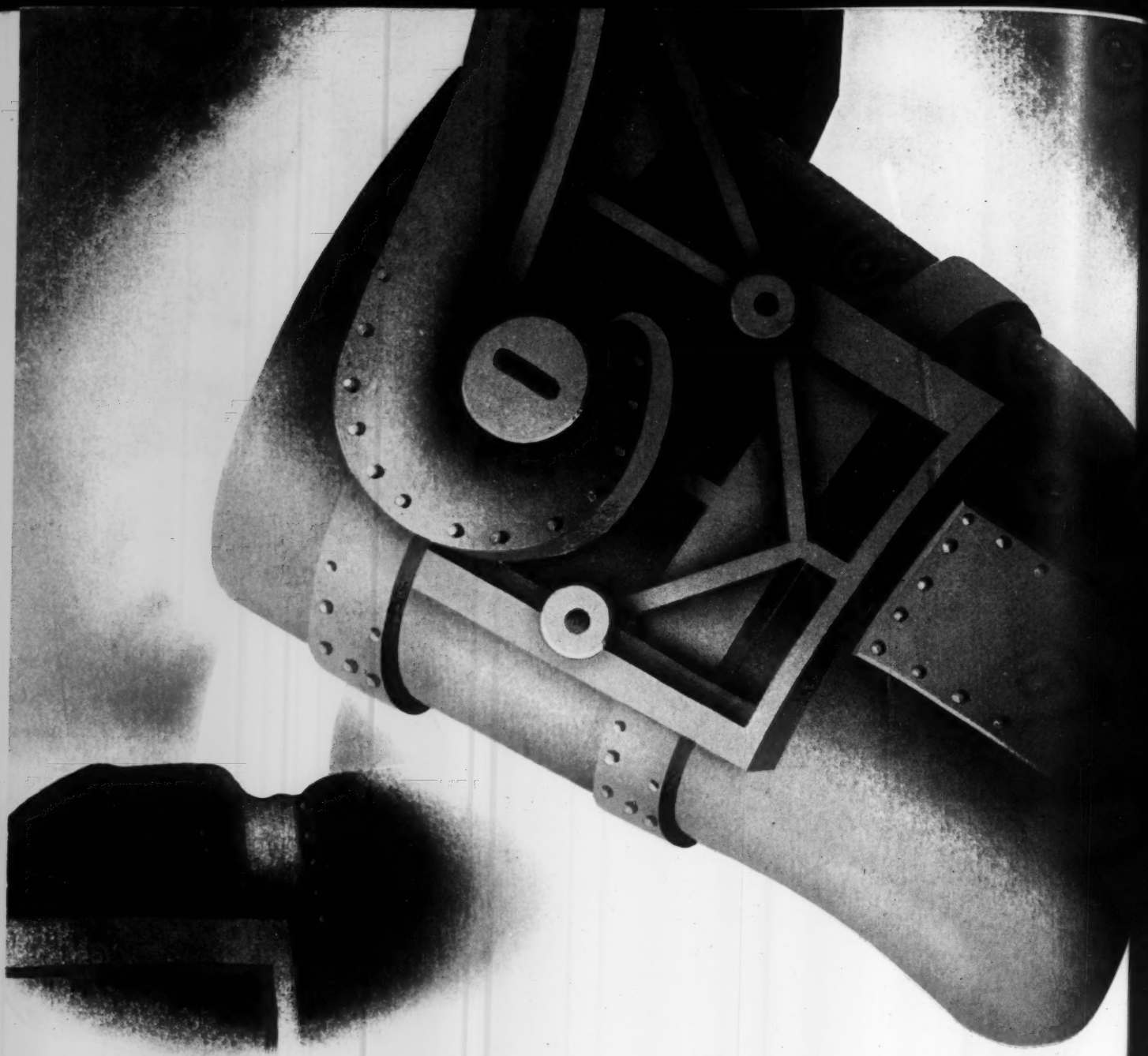

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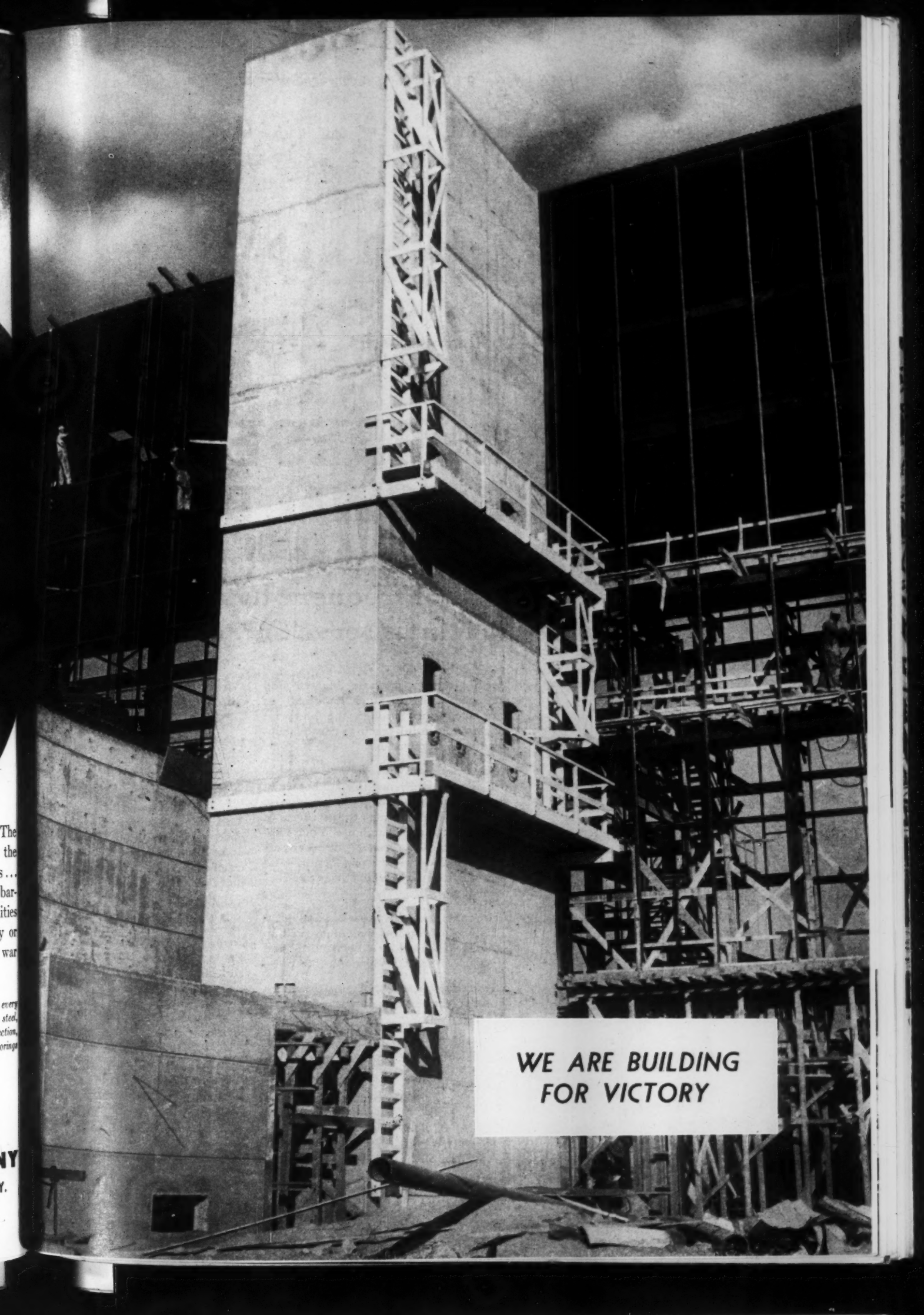
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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Engineer Operations in a Theater of War

From an Address Before the Annual Convention of the Society, Los Angeles, July 28, 1943

By MAJ. GEN. EUGENE REYBOLD, M. AM. SOC. C.E.
CHIEF OF ENGINEERS, U.S. ARMY, WASHINGTON, D.C.

NO group in America has a deeper interest in, or a greater right to know, the facts of "Engineer Operations in a Theater of War" than that great profession represented by the membership of the American Society of Civil Engineers. But to attempt to cover these large and diverse tasks is almost as tough an assignment as the accomplishment of the tasks themselves.

Diversity in Home Operations.—A theater of war includes those areas of land, sea, and air which are, or may become, directly involved in the conduct of war. On this basis, few areas of the globe can be eliminated. Let us commence with the zone of the interior—the United States itself. Here, practically over night, the permanent organization of the Corps of Engineers—together with the technical skill of our common profession, plus the driving power and magnificent equipment of the construction industry—was called into service.

Camps were designed and constructed; airfields were built and expanded; industrial plants for the manufacture of munitions, ordnance, and equipment arose over night; storage depots, ports of embarkation, harbor defenses, housing, and miscellaneous facilities were carved out and erected for the fullest, fastest possible use. Hand in hand with all these projects, general and station hospitals were built. Port facilities and thousands of miles of highways and railways and waterways were provided to carry a transportation load which increased by leaps and bounds.

This story has been well and frequently told. However, with the completion of more than 90% of the dollar value of this unprecedented eleven-billion-dollar construction program, the impression persists that the engineers' construction job at home is done. This is not the case. Hardly a facility but needs some improvement, and every facility requires the management and direction of a post engineer, whose job may well be called a combination of city manager and city engineer.

Difficulties Experienced Elsewhere.—Incalculable though this program may be, it includes only continental United States and some offshore bases. Other bases of operations, of course, had to be constructed at strategic places about the globe.

To recall military conditions as recently as the fall of 1942 is to confess that our arms were everywhere undergoing critical days. This was true in Britain, in North Africa, in the Far East, in Russia, in the Aleutians, and on the seas. The picture was a black one, indeed. But the fact remains that engineer equipment—moving by engineer-arranged transportation and bringing goods from plants built by engineers—began first to trickle and then to flow to all these endangered spots.

One Exploit Illustrates Success.—Slightly more than a year ago a Japanese task force moved in to the attack of our Aleutian Islands. Advancing cautiously and unseen under protective clouds and fog, these warships, aircraft carriers, and transports fully intended to reduce and occupy our most important Aleutian base.

Within sixty miles of Dutch Harbor, the carriers emerged from the cloudbank and discharged loads of fighters and bomber planes. They expected, at most, the opposition of antiaircraft guns and a few flying boats. What they actually received was the surprise of their yellow lives. From an airfield on Umnak Island, sixty miles west, our P-40 fighters and B-26 bombers arose. The existence of this field, completed only a few short days before, was completely unknown to the Japanese.

To avoid bombing and strafing, the Jap warships and carriers ducked back into their protective covering of clouds. Few were the planes that found their carriers again. The surprise forced the Japs to withdraw westward and abandon their intentions to take Dutch Harbor.

Feats Repeated.—That field on Umnak Island had been built by a battalion of engineers which for months had wrestled ceaselessly against the now-famous Aleutian rock and tundra and foul weather. The engineers carved that landing field out of rough terrain that men of lesser courage and ability would have overlooked in airfield reconnaissance. Thus, they were prime factors in turning back the Japanese assault.

The next job of airfield construction in the Aleutians went a lot faster. On August 30 the same battalion moved to Adak Island, 260 miles east of Japanese-held Kiska. Exactly twelve days later, the first U. S. Army planes landed. In this short time engineer troops, starting from scratch, had ingeniously constructed a landing strip by partially damming up the mouth of a creek. Into the lagoon so formed they pushed a heavy fill, soon covered with a steel mat.

Many of these courageous engineers are members of the Society. And they will one day amaze us with their tales of the refinements ignored, of minimum standards, and minimum comforts, despite which they produced vital construction at this combat front.

In South Pacific and Africa.—At Milne Bay the same kind of engineer troops, finishing an airport, abandoned their equipment, unslung their guns, and drove the attacking Nipponese back into the sea. Others in New Guinea hacked dozens of airfields out of the mountainous jungles behind the Japanese lines. Their fellows drove the Alaskan Highway nearly 1,700 miles through some of the world's most inaccessible brush and mountain and muskeg-infested terrain.

The ink is scarcely dry on the headlines-of-praise for engineer-built forward airdromes in North Africa. When Oran capitulated in November 1942, there were only nine suitable airfields in the whole North African area. By May, a total of 127 airdromes were in operation. Engineer troops employing American-made equipment did this job.

And airport operation means petroleum distribution. This in turn means engineers to locate, construct, operate, and maintain military pipeline systems for supply in theaters of operations. With gasoline and oil constituting more than half the dead-weight tonnage moved to the front during the North African campaign, the pipelines—designed, located, and placed by engineers—helped to solve the tremendous supply problem.

In Sicily Also.—A July report from Sicily points out that within 24 hours after they landed, under strafing attacks by Nazi planes, American engineer units accompanying the invasion troops had built and made ready for service a complete landing field for Allied fighter planes. "We just grabbed the flattest wheat field we could find and went to work," said the lieutenant in charge. "In 24 hours we had a taxi trail all around the field, the runway ready for gasoline, ammunition, and oil to supply the planes. We landed at eleven a.m. and by five p.m. that same day we were turning that wheat patch into an airport."

These engineers didn't even knock off to hunt standard Army grub; they just feasted briefly on tomatoes and melons in the fields and then pitched in again. A patrolling Air Force captain circled and landed. "Have you plenty of Ack-Ack, guns, food, and gasoline?" he asked.

"We are set up to do business," answered the lieutenant.

"We have scores of aircraft and hundreds of men. Can you take us?" came the question.

"O.K., come on in," said the lieutenant.

This sort of thing the world calls engineering miracles. But behind them stand engineering experience, the engineering of map production, the engineering of transportation and construction, and the sheer grit and plain hard work of a young American generation—reputed by Hitler to be degenerate—of whom General Pershing said in World War I: ". . . the scientist said it couldn't be done, but the fool engineer didn't know that—so he just went ahead and did it."

Varied Tasks Overseas.—Engineering operations of all kinds, including construction, are moving overseas. To man these various types of units, we must recruit, put in uniform, and train 9,000 engineer specialists each month. We urge Society members to assist us in this recruitment.

Air-borne engineer battalions are assigned the job of helping to gain and to hold objectives. Engineers, dropped by parachute, are prepared to demolish enemy communications, airdrome installations, factories, docks, utilities, supplies, and equipment. They also execute minor and hasty repairs to existing landing fields so that other air-borne elements may come in to make more extensive improvements.

Port construction and repair groups got their test in the North African campaign. With sunken ships clogging the ports of Casablanca and Oran, and with other ports subjected to frequent bombardment, port repair and operation presented the utmost engineering difficulties. Other engineer units did masterful jobs in keeping railroads operating at maximum efficiency.

Widespread Activities.—Speaking now of home-front emergency operations, a few weeks ago the rivers in our mid-West were threatened with "one hundred year floods." In fighting them, engineer general service regiments, operating under pre-determined plans and starting from scratch, fortified and rebuilt levees which withstood the ravages of rushing water for the first time in history. These engineers were the brothers of other engineers who bridged the roaring rivers in Canada and Alaska—and who will bridge the waterways of Europe as we pound our way to Rome and Berlin to make good the unconditional surrender demanded by our Commander-in-Chief.

The Engineer Amphibian Command has just celebrated its first birthday. Its mission is to transport combat units to selected landing beaches for the assault, to evacuate the wounded, to handle prisoners, to salvage equipment, and to supply the combat troops. In actual operations, their boats hit the beaches at high speed and combat troops race ashore over low ramps. After assault waves have been put ashore, engineers land light-weight earth-moving equipment to prepare roads, establish communications, and develop unloading and distributing points. In the landings at Safi, French Morocco, last November, an American battalion even operated a railroad and supervised port operations.

In theaters of operation, engineers help to impede movements of the enemy by laying mine fields and creating obstacles, by furnishing technical assistance and engineer supplies to other arms of the service, and frequently by actually engaging in combat. The removal of mines in an advance is just another engineer's job.

On the Offensive.—From the beginning of hostilities I have reiterated the subject of my previous address before the Society (CIVIL ENGINEERING, June 1942), "This is an Engineer's War." Not only have the Army Engineers demonstrated this truth, but they are engineering the victory to the point where even the public is learning of their magnificent feats.

We are still a long way from Tokyo. The victorious conclusion of this war remains a grave and tremendous undertaking. Right now the tide of battle seems to be running in our favor. We know we have passed the days of fighting desperate defensive battle to avert defeat—we are now fighting battles of offense.

The voice of righteous retribution is thundering in Nazi ears as Allied bombs fall on them with relentless intensity. But in the dawn of victory, let us not jeopardize our position by any overconfidence or complacency. The major job is yet ahead. We must not fail.

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NUMBER 9

Flow Diversion at Niagara Falls

III. Construction of the Niagara River Weir

By HARLAND C. WOODS, M. AM. SOC. C.E.
LIEUTENANT COLONEL, CORPS OF ENGINEERS, U.S.A., BUFFALO, N.Y.

SO that additional volumes of water could be deflected from Niagara Falls for war power generation, a rock weir has been constructed in the main river channel. The rigging and operation of the cableway used in the construction is explained in this paper, which is third in a series begun in the July issue. Colonel Woods' paper was presented before the joint meeting of the Society and the Engineering Institute of Canada at Niagara Falls.

IN addition to its present utilitarian function—diverting water for power generation—the Niagara River weir will help to preserve the beauty of the cascades and falls. As a result of the construction of the rock weir, the elevation of the pool above the cascades has been raised about 1 ft, which in turn has increased the firm power in all plants affected by 30,000 hp. Flow around both sides of Goat Island has been increased, thereby improving the appearance of the American side of the Horseshoe Falls and the American Falls. This flow has been diverted from the main channel of the Horseshoe Falls.

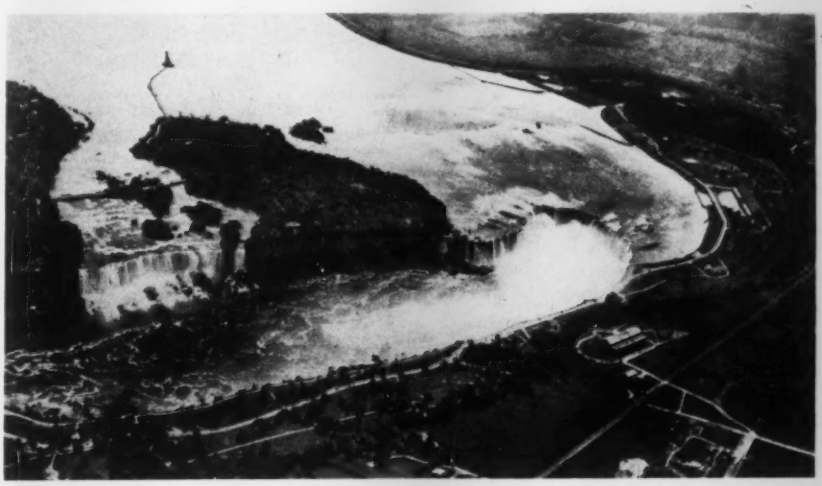
The submerged weir was constructed about one-half mile upstream from the first main cascade. It extends from a point about 350 ft from the Canadian shore, about 1,800 ft northerly to an artificial island in the middle of the river. The opening between the bank and the weir is provided to insure that the flow going to the power plants along the Canadian downstream shore will not be decreased. The weir is 5 ft under the water surface, and about 40 ft wide on top, with the idea that it would raise the water level the desired amount without showing above the water surface to detract from the view there or interfere with ice flow.

It is built of stone, with an upstream surface composed of large flat slabs and downstream toe of heavy blocks, the space between filled in with graded sizes of stone, topped off by large blocks as a top sill for the weir. Over 30,000 tons of stone were required, including riprap along the Canadian shore.

CONSTRUCTION EQUIPMENT

As originally planned, the weir was to have been built by erecting on its center line a steel scaffolding, weighted platform extending out from the Canadian shore. Using this as a working platform for trucks hauling stone to a derrick on the outer end, the building of the weir would begin at the outer, or northerly, end and proceed toward the Canadian shore, the scaffolding being removed in sections as the work progressed. However, this method would have required two seasons for the work and necessitated the use of much critical material. It would also have been costly, and allowed for variation in the length only of the weir.

Consequently definite study was made of other possible ways of doing the work, and it was decided that the rock shoal extending from the upper end of Goat Island would make possible the use of a cableway. This cableway is supported on two traveling towers—the head tower on the Canadian bank of the river, the tail tower on the artificial island in the middle of the river (Fig. 1). These towers have been used on two previous U.S. Engineer Department cableway jobs—Denison Dam in Texas, and Conchas Dam in New Mexico. At Denison Dam the span of the cableway was 1,680 ft and the permissible load 20 tons; at Conchas Dam the span was about 1,400 ft. At Niagara the span is 2,600 ft, and the permissible load 10 tons. The towers, which are of the counterbalanced type, are 150 ft high, and the normal sag of



AIR VIEW OF FALLS—TOWERS FOR CABLEWAY APPEAR NEAR TOP OF PHOTOGRAPH

the cable is 130 ft (Fig. 2). On the back side of the towers there are 250-ton counterweights, which overcome the overturning effect of the cable pull on the head of the towers. This pull totals 300,000 lb, of which 241,600

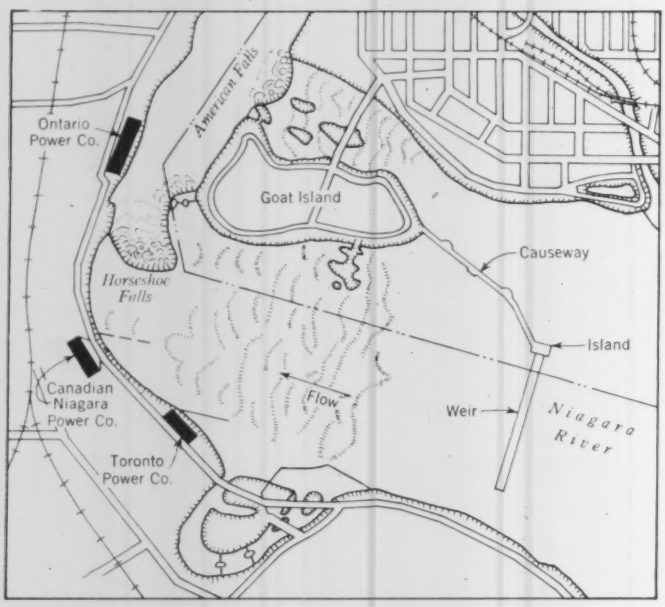


FIG. 1. MAP SHOWING LOCATION OF REMEDIAL WEIR IN THE NIAGARA RIVER

lb are from the main track cable, 28,000 lb from the secondary track, and 30,500 lb from the electric messenger line.

To transmit the resultant side thrust into the underlying material, the trucks on the river side of the towers are set at an angle so that there will be no side thrust from the wheels to the rails on which they move. The total thrust to be transmitted to the ballast by the river-side trucks under the towers under full load conditions is 850,000 lb. Reduced to load per foot under the trucks, total thrust amounts to 36,000 lb, as compared to 17,000 lb per foot under locomotive drivers for Cooper's E-60 loading.

The main cables between the two towers consist of a $2^1/_2$-in. main track cable, on which the carrier with the rock-transporting equipment travels; $^3/_4$-in. inhaul-outhaul endless line for moving the carrier; a $^3/_4$-in. hoist line for raising and lowering the loads; a button line; and a $^3/_4$-in. closing line for operating the grappling equipment. Stringing of the cables was tricky and complicated. In this location, just above the Falls with unknown conditions of the river bottom, it was impossible to risk men or floating plant to cross between the towers, and stringing the first line between the towers was accomplished by a large kite.

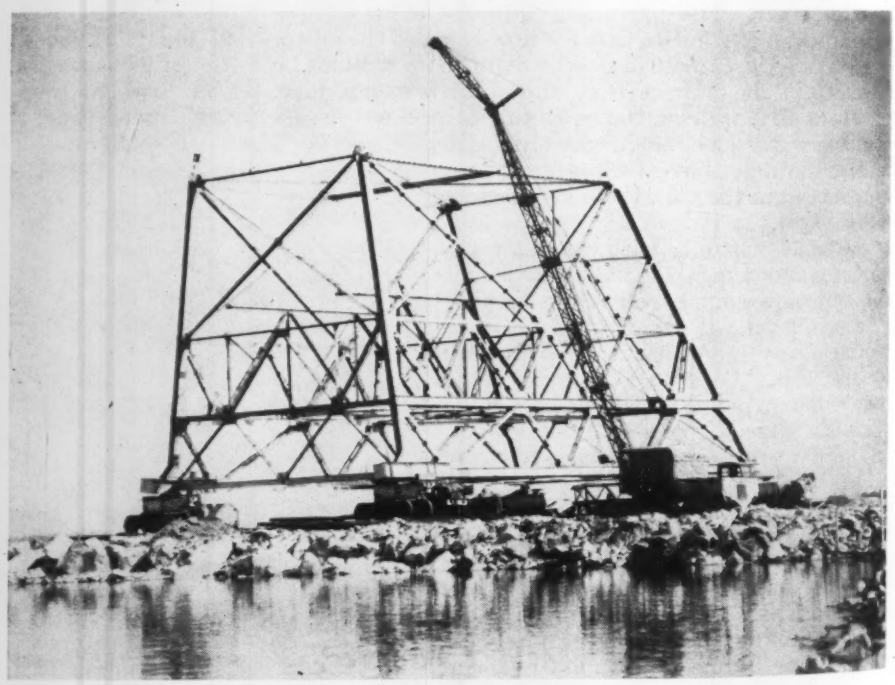
The prevailing winds are from the west or southwest, and on a favorable day a hemp kite line was carried from the head to the tail tower. Before it could be drawn taut, it broke. For a second line, a piano wire was flown across. This held, and with it a $^1/_8$-in. steel aircraft cord was pulled over. The successively larger lines were $^1/_4$, $^3/_8$, $^1/_2$, $^3/_4$, $1^1/_4$, and $2^1/_2$-in. cables. The smaller lines were hauled across suspended at the two ends only, the hauling being done by truck, caterpillar tractor, or winding drum on a "jenny" truck, the tail tension being supplied by a truck or a brake on the reel from which the cable was being paid out.

At the beginning of cable-stringing operations an effort was made to keep the cables out of the water for fear of fouling them on boulders which were thought to be strewn over the river bed. Because of the swift currents of from 5 to 8 ft per sec in the area just above the Falls, it had never been possible to sound or sweep the area before the cableway was erected, and presence of numerous boulders in the river bed upstream from the site led to the conclusion that boulders must be expected at the site of the work. Eventually, however, several lines did get into the water, and although they were bellied downstream several hundred feet no fouling occurred; and from then on no particular care was taken to keep the lines out of the water.

The large track cable has a heavy socket casting on the end and a $1^1/_4$-in. line was used as a messenger line to support this casting when this line was pulled across. With the consequent restraining effect of the messenger line, the track cable was bellied downstream very little. After the main-track cable was up and the carriage mounted with the inhaul-outhaul line, the remaining lines were more readily strung as spare lines were rigged for hauling the various succeeding lines into position.

OUTRIGGERS ERECTED ON TOWERS

An innovation in cable arrangements was necessitated by the physical conditions at the site. Power and control lines had to be connected between the towers, and means of inspecting the stone in place were desired. These requirements were met by building outriggers 10 ft long on each tower. Downstream and parallel to the main-track cable, one pair of outriggers supports a 1-in. secondary track cable with $^1/_2$-in. endless inhaul-outhaul line to move the carrier.



ERECTION OF TAIL TOWER ON ARTIFICIAL ISLAND

Upstream from the main-track cable and parallel thereto, the other pair of outriggers support a 1-in. messenger line carrying the electric power and control lines. The electric power line carries a 3-phase, 2,200-volt circuit. The control line is made up of 10 pairs of light wires, through which the operator in the head tower controls the movement of the tail tower. Main transformers are on the Canadian shore; others are on or near each tower.

To build the artificial island and to afford access thereto for the erection of the steel of the tail tower, a causeway was built from the upper end of Goat Island through the shallow water. A grade high enough to avoid overtopping at ordinary high water was determined for the causeway, but it is expected that it may be overtopped several times before it is removed.

This causeway, consisting of a single-track roadway with three turnouts provided to facilitate movement of trucks during the construction work, is about 2,200 ft long and averages 6 ft in height. While building the causeway, the trucks carried stone to the head of Goat Island, backed from there out to the end of the fill, and dumped their load until the first turnout had been completed. Next they drove out to the first turnout, turned, and backed to the dumping point, until the second turnout was reached; then the process was repeated. In this way, the amount of backing was reduced and the progress of the work speeded up. At many points stone for the causeway was placed in currents as swift as 6 mph. By using stone ranging from 150 lb to 3 tons in weight for the bottom courses, none was lost through displacement by the current. Mixed sizes of stone were used above the water level and crushed road-surfacing stone spread over the top. Twenty-one thousand tons of stone were required for the causeway.

The island, which is about 140 ft wide and 200 ft long over-all, was built a foot higher than any high water yet recorded for the site. In it there are two rows of cribs under the tower tracks which are 76 ft 10 in. apart center to center. The back crib is a rectangular vertical crib, 14 ft wide; the front one, through which must be transmitted the thrust of the tower, is 13 ft wide on top, widening out at the bottom to about 18 ft. (See Fig. 3.)

The towers were received disassembled from Denison. The material for the head tower was received at Chippawa, Ontario, and that for the tail tower at Niagara Falls, N.Y. Erection of the towers was by means of a stiff-leg derrick and gin pole at the head tower and by auto crane and gin pole at the tail tower. The heaviest single piece of the tower proper weighed $7\frac{1}{2}$ tons. This was the crown block. To hoist it into position a special gantry was made. The tackle on this raised the piece from the ground level, and when the desired height was reached the gantry was swung over to bring the block into its proper position relative to the tower frame.

MAIN $2\frac{1}{2}$-IN. TRACK CABLE WAS SO HEAVY THAT LOAD HAD TO BE DISTRIBUTED FOR BRIDGE CROSSINGS

The heaviest single piece of equipment was the reel with the main-track cable which, with the transporting truck, weighed 35 tons—more than was considered safe for the bridges to Goat Island. To take the cable over, a second reel was built. One-half of the cable was run off the receiving reel onto the auxiliary reel. Then the two reels, carried on separate trailers, were hauled over the bridges to Goat Island by a truck, the three vehicles being coupled a sufficient distance apart so that not more than one of them would be on a bridge at a time.

ROCK CARRIED FROM CANADIAN SHORE

The stone was brought to the river side of the head tower on the Canadian shore in trucks and trailers. It was then picked up by the cableway equipment, transported to the desired point in the river, and deposited there from above the water level, the actual movement of the load being under the control of the operator in the head tower. In the first trial runs an attempt was made to place the stone on the bed of the river. This proved impractical because the current would carry the stone from 25 to 50 ft downstream. Next, stones were released just above the water surface. As the resulting surge and oscillations of the various cables were not violent, stone was finally dumped from the traveling elevation. Communication between the operator, the inspector, and the tail tower, was by radio and by telephone.

While the cableway can hoist a load at a speed of 300 ft per min and tra-

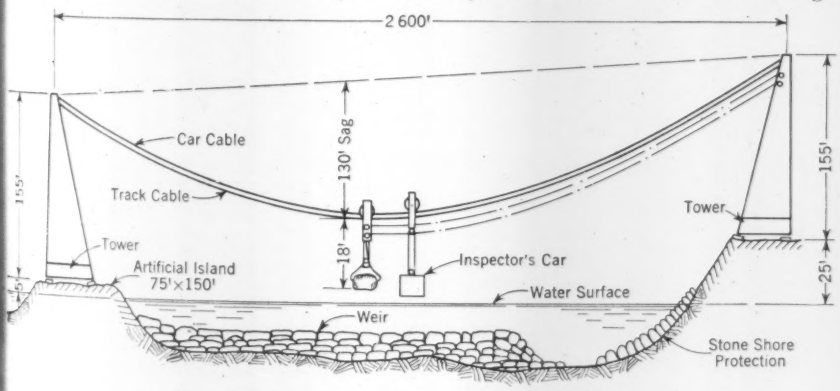
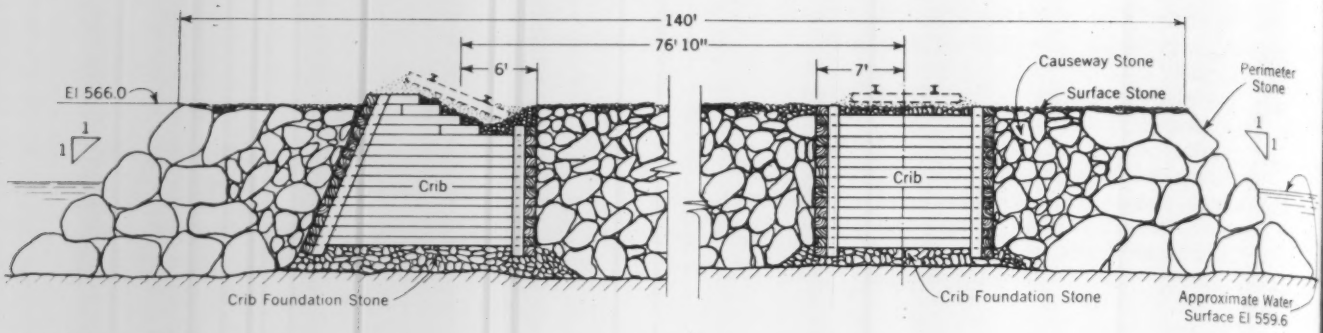
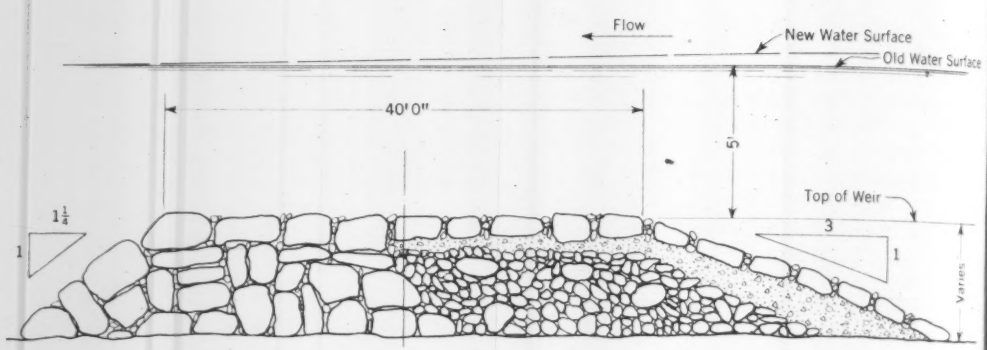


FIG. 2. PROFILE OF CONSTRUCTION CABLEWAY



TYPICAL SECTION OF ISLAND



TYPICAL SECTION OF SUBMERGED WEIR

FIG. 3. SECTIONS OF WEIR AND ARTIFICIAL ISLAND

verse it at 1,600 ft per min, experience has shown that it takes about 5 min to make a round trip, and the rate of placing averages about 400 tons per day. If the stone being handled is large blocks, stone hooks are used; if it is smaller stone, it is handled in skips.

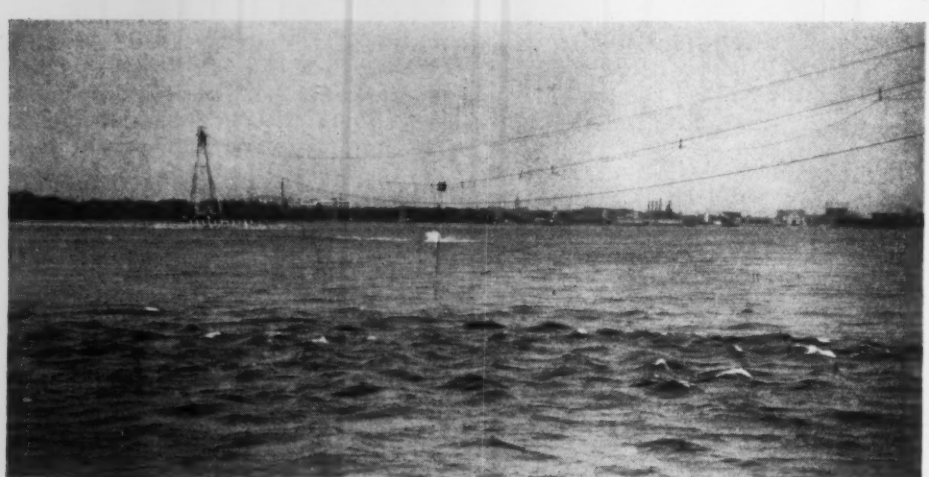
The large stone at the downstream toe of the weir was placed first, smaller mixed stone deposited next, just upstream therefrom, and the dumping was progressively upstream until the large upstream facing stone was placed (Fig. 3). The last was the surface covering of large blocks with the surrounding mixed stone, which was placed at the elevation determined by the hydraulic observations and studies that were carried on simultaneously while the stone-placing work progressed.

FUTURE CHECKS ON THE WORK

As explained by Mr. Cline in the August issue of CIVIL ENGINEERING, as the work progressed changes in water levels were noted, and the final dimensions and elevations of the weir were determined as the work approached completion. For this reason, and also because it is not known how much maintenance work will be required for the weir, the cableway will be left in place for several years. Then if experience should indicate that repairs or alterations are desirable, they can be made. When it is decided that the best results practicable have been attained, the cableways (towers included) and the causeway to the island will be removed. The island will be landscaped and remain as a permanent addition to the scenery.

This work does not constitute the complete plan for the beautification of the Falls and further development of the power resources there. Some excavations in the channels leading to the flanks of the Horseshoe Falls and some diverting submerged weirs in the deeper channels in the rapids above the Horseshoe are contemplated to spread the flow over the crest, and reduce the volume at the throat of the Horseshoe where recession due to the heavy flow is the most rapid.

Construction of the temporary causeway and of Tower Island, and the erection of the tail tower were the responsibility of the Buffalo office of the U.S. Corps of Engineers, while erection of the head tower and cables, provision of the electrical supply, and placing of the stone in the weir were by the forces of the Ontario Hydroelectric Power Commission. Smooth functioning throughout was effected by the effort made by both sides to cooperate in the work. Messrs. C. G. Cline, E. K. Beam, Otto Holden, D. Forgan, and J. J. Traill, in particular, were helpful to the Corps of Engineers personnel and to E. K. Eldridge, the consultant; Messrs. E. M. Robbins and B. J. Witzig, from the Buffalo District office, ably supported the writer in their several capacities.



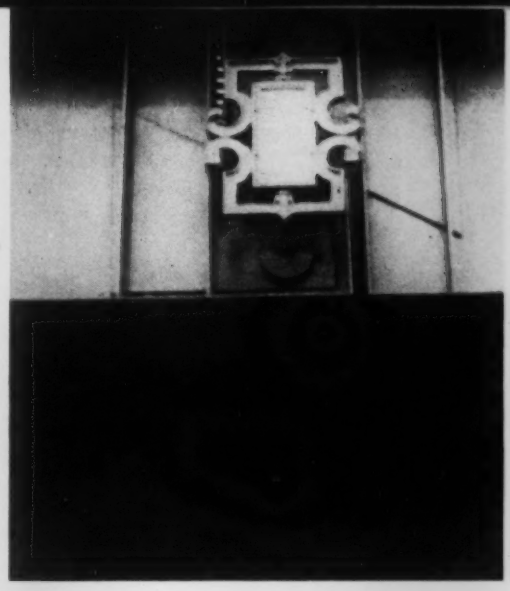
GRAPPLE HAS JUST RELEASED ITS LOAD IN MIDSTREAM
ISLAND IN LEFT BACKGROUND

Welded Plate-Girder Bridge Separates Connecticut Highways

By JOHN F. WILLIS, M. AM. SOC. C.E.

ENGINEER OF BRIDGE DESIGN, CONNECTICUT STATE HIGHWAY DEPT., HARTFORD, CONN.

UNUSUAL both in design and fabrication methods, this structure was under construction before the present priorities for steel went into effect. Over twelve miles of fillet welding was used, and it proved to be economical both of materials and of labor. Unit price data are also furnished by Mr. Willis in this article, a shortened form of a paper which was a prize winner in the latest competition of the James F. Lincoln Arc Welding Foundation.



LINK CONNECTION BETWEEN SUSPENDED SPAN AND CANTILEVER SPAN
The 34 Connections Are Identical

SITUATED in the town of Wethersfield, Conn., the Jordan Lane Bridge is one of nine grade separations which now carry the Hartford Bypass, a dual parkway connecting U.S. Route No. 5 with the new Connecticut River Bridge between Hartford and East Hartford. Because of the irregularity of the intersection to be overpassed it was decided that a single span 165 ft in clear width, or at least a series of spans without an intermediate support, would give the only really satisfactory solution. Even with this long span, it was necessary to use piers narrower than the supported roadway, which is 83 ft 10 in. wide, in order to leave the intersection beneath unobstructed. The abutments were set back sufficiently far to clear all street lines.

The center suspended section and the two cantilevers give a total clear span of about 165 ft, or 170 ft center to center of piers. Two anchor spans, of 80 ft each, bring the total length center to center of end bearings to 330 ft. At the piers the roadway, which is considerably wider than the piers, is carried on two double cantilever arms. Owing to the extremely high bending moment in these members, they are double or of the "box" type. Had it been possible to use piers of a width equal to that of the abutments, the cost of the structure would have been greatly reduced and its erection likewise simplified.

SIMPLIFIED DESIGN

As the structure is statically determinate, the design was for the most part quite simple. From the accompanying sketches, Figs. 1 and 2, it will be noted that, except for the sway bracing which is composed of angles, the entire steel superstructure consists of plates and flats and is assembled solely by arc welding.

Three factors determined the depth of the suspended girders, clearance, grade, and cost of right of way. A saving of metal would have been possible by increasing the depth of these girders, it is true, but certain underclearances had to be maintained and every foot the grade was raised added greatly to the cost. The approach side slopes are 1:2, which means that for every foot of height the width increases 4 ft, and acquisition of real estate was both difficult and expensive.

It may be of interest to give a list of the contract items and unit prices as bid by the contractor in May 1941:

ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL
Clearing and grubbing	L.S.	....	....	$ 500.00
Bridge excavation*	Cu Yd	4,400	$ 1.50	6,600.00
Stone for drains*	Tons	70	2.00	140.00
1/2-in. expansion joint	Sq Ft	830	0.50	415.00
Deformed steel bars	Lb	438,560	0.04	17,542.40
Structural steel*	Lb	1,700,000	0.075	127,500.00
Metal bridge railing	Lin Ft	800	12.00	9,600.00
Class "A" concrete*	Cu Yd	4,280	14.00	59,920.00
Cast stone	L.S.	....	....	15,000.00
Cast-stone ornaments	Each	4	50.00	200.00
Cast-iron ornaments	L.S.	....	....	2,500.00
Copper flashing	Lb	710	1.00	710.00
Portland cement	Bbl	6,225	2.40	19,940.00
Total bid for contract items				$255,667.40
State's estimate for above items				256,699.50

* Items so marked were bid by contractor at the same unit price as was estimated by the state.

It was also highly desirable that the grade be kept low so as to minimize the amount of borrow required. There was little fill material in the vicinity; the haul was long and consequently expensive.

In the 120-ft suspended span, all longitudinal girders excepting the one at the center are united to the roadway slab by reinforcing bars, welded to the top flanges of the steel girders. Thus horizontal shear between these elements is effectively developed. This converts the simple steel girder into a "composite" section, similar in its analysis and action to the concrete T-beam. The center girder was not tied into the slab in this manner for two reasons. It was necessary to allow for lateral expansion and, furthermore, the increased depth of girder possible under the center strip developed sufficient section to meet moment requirements.

The anchor spans are designed for two different conditions of

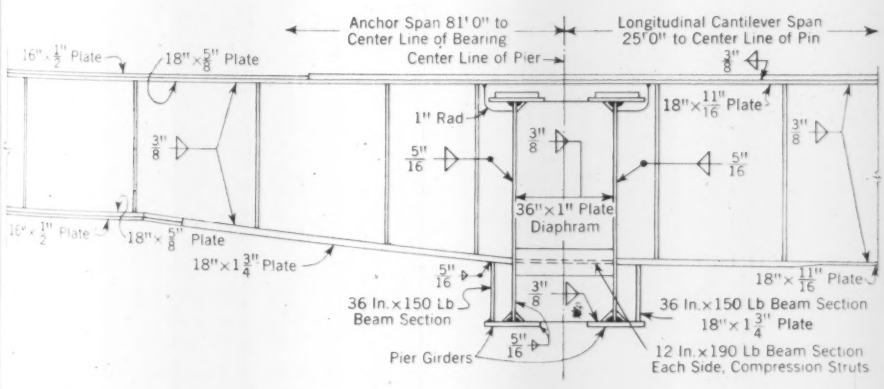

Anchor Span 81'0" to Center Line of Bearing
Longitudinal Cantilever Span 25'0" to Center Line of Pin
Center Line of Pier
16" × 1/2" Plate
18" × 5/8" Plate
3/8"
1" Rad
5/16"
18" × 11/16" Plate
36" × 1" Plate Diaphram
18" × 1 3/4" Plate
36 In. × 150 Lb Beam Section
Pier Girders
12 In. × 190 Lb Beam Section Each Side, Compression Struts

FIG. 1. SECTION THROUGH PIER GIRDER SHOWING CONNECTION OF ONE OF THE 17 LONGITUDINAL GIRDERS

JORDAN LANE BRIDGE AT WETHERSFIELD, CONN.
Medallions in Center Span Next to Piers Cover Connecting Links for the Suspended Girders

loading. During construction it was specified that the concrete deck on each anchor span should be poured first. Also it was foreseen that much of the equipment used in the erection of the remainder of the bridge would be installed on this span. It was therefore deemed advisable to design it as a simple span, carrying the full dead and live loads subject to a slight reduction, because of the weight of the cantilever arms which created some negative moment.

SECOND CONDITION OF FULL DEAD AND LIVE LOAD

The second condition occurs after the bridge is completed and open to traffic. Then longitudinal cantilevers and suspended spans receive the full dead and live load, while dead load only is placed on the anchor span. The additional section in the anchor span necessary for the excess of negative over positive moments is provided by the extension of the heavy cover plates at and adjacent to the pier girders. At the point where the outer cover plate (16 by $1^1/_8$ in.) can be reduced but some additional flange area is still necessary, a smaller plate is added (16 by $^1/_2$ in.) by butt welding to the heavier plate to maintain continuity. To augment the section at the butt joint, which is calculated to withstand a stress of 13,500 lb per sq in., two plates, 6 by $^5/_8$ in., are welded under the upper joint and over the lower joint. It was only necessary to carry the extra cover plates to a point near the center of the span; from there to the abutment end the section is sufficient for the moments involved.

The specifications for this project require that whenever plates are to be spliced, this shall be done before assembly. Thus all spliced girder flanges are welded together before being welded to the girder webs, thereby reducing or eliminating stresses "locked up" due to shrinkage. However, field splices united longitudinal cantilevers with anchor girders.

While this bridge now occupies and practically covers all of what was once known as "Goodrich Square," there seems to be but little local opposition to it, principally because of its fine appearance. As far as the writer has been able to determine, it is the largest purely highway grade separation in New England, not only with regard to total span and width, but also in the matter of quantities of material, width of the area of intersecting streets on the lower level, and the money involved.

There are 1,700,000 lb of carbon structural steel in its makeup, and about twelve tons of welding rods or electrodes. The total length of all the fillet welds, if put end to end, would be something over twelve miles.

Welding proved to be readily adaptable to any and all conditions met during fabrication and erection. A change from continuous welding to intermittent welding on the top cover plates of the longitudinal girders over the transverse girders was made. A review of the design showed that this was possible and a saving was effected. This was also done at the extension cover plate on the top flange of the anchor span girders where there occurs a reversal of stress. An adjustment in price was effected as this was not figured in the original design and cost analysis.

It has always been the writer's firm opinion that welding could best be promoted by proof of its economical use. Some of the fillet sizes and amounts of welding called for in the case of this structure are in excess of those required to meet stress conditions, but this is because the bridge was designed under specifications which are unreasonably conservative, a condition which the writer is confident will soon be corrected. Despite this fact a careful estimate showed that a riveted design required 32% more steel and would have cost an additional $6,660, more than the entire cost of field and office engineering.

The project was designed by the author, and fabricated and erected by the American Bridge Company, who were the subcontractors for the Mariani Construction Company, general contractors of New Haven, Conn. The structure was built for the Connecticut State Highway Department.

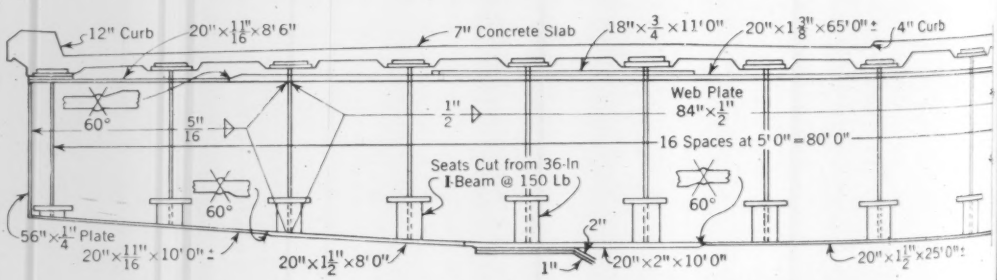


FIG. 2. HALF ELEVATION OF PIER GIRDER SHOWING ARRANGEMENT OF LONGITUDINAL GIRDERS

Steel-Penstock Erection at a Western Hydroelectric Project

By L. G. CHRISTOFFERSON, JUN. AM. SOC. C.E.
ERECTION ENGINEER, CHICAGO BRIDGE & IRON COMPANY, CHICAGO, ILL.

SHORTAGE of water and electric power in Arizona made necessary the construction, a decade before it was originally planned, of the power plant at Parker Dam. This work followed by two years the completion of the dam, which in the ensuing period had been used for river regulation only. An unusual feature of the power project was the erection of four steel penstocks, 22 ft in diameter. In this article Mr. Christofferson describes the equipment and methods used in fabricating and placing these huge pipes.

THE penstocks at Parker Dam pass through the rock abutment, as shown in Fig. 1, separating the power house from the forebay. The 22-ft-diameter pipes of plate steel, with heavy support and stiffener rings, are encased in concrete throughout their length, which aggregates about 700 ft. Prefabricated sections, which were shipped from the Chicago shop of the Chicago Bridge and Iron Company, contractors for fabrication and erection, were assembled in the forebay area at the site. All the main seams possible were automatically welded and X-rayed to detect flaws. The plate thicknesses varied from $^{15}/_{16}$ in. thick at the downstream end of all the penstocks to $^{5}/_{8}$ in. thick at the upstream ends.

It was decided that a guyed derrick on top of a tower would be the best means of unloading steel and also of serving the assembly yard. Accordingly, a derrick of 40-ton capacity, having a 135-ft mast and a 90-ft boom, was set on top of a tower 60 ft high. The derrick was located midway between the center lines of tunnels Nos. 2 and 3 and as far away from the upstream portals as possible, while keeping the unloading point within reach. The 135-ft mast and 90-ft boom lengths were chosen so that there would not be any interference with mast guy lines when swinging around with a load.

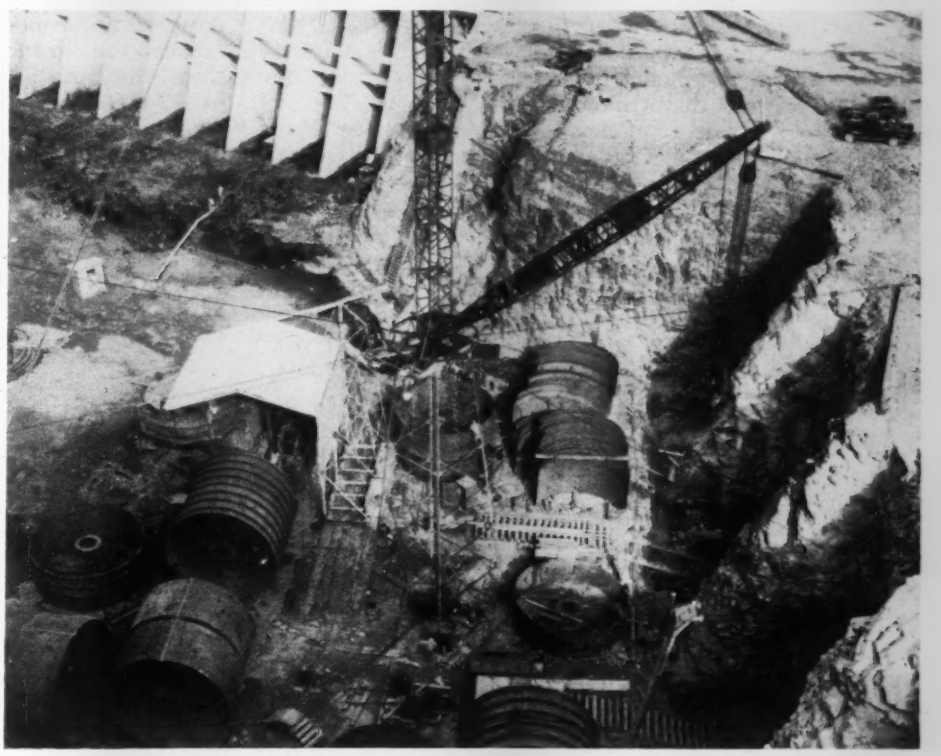
The available working area under the derrick was laid out with the idea of allotting as much space as possible to the assembly area, but keeping the automatic welding equipment close to the derrick. Definite places were allotted for storage, assembly, welding, X-raying, fitting, and welding of stiffeners, and these same locations proved satisfactory so they were used throughout the job. A tractor-drawn boom was used to move small pieces, such as segments of stiffener rings, spiders, and other bits of materials, out of the working area of the derrick. This tractor crane proved to be of great value for various uses throughout the job.

For assembly, three plates rolled to a true radius were set on an assembly bed and the longitudinal joints were keyed together. While this operation was being performed, another crew of men started installing the temporary spiders. Each spider was made up of a central plate ring and eighteen 1-in. round rods connecting the ring to the shell of the penstock. These rods were threaded into nuts which had been welded to the plates in the shop. Since all rods were of the same length, tightening the nuts on the rods, so that the same amount of thread protruded through the nuts on all rods, pulled the penstock ring into a practically true circle.

LONGITUDINAL SEAMS WELDED

As each ring was fitted completely, it was turned so its axis was horizontal and set on the inclined ramp roller carriage for welding of the longitudinal joints. This carriage traveled down a 5° slope on a railroad track while the welding head remained stationary. Its speed was controlled by a worm-drive shaft which was connected to a variable-speed motor and reducer mechanism. The travel speed could be adjusted for the various welding speeds required. On top of the carriage were four steel rollers installed at right angles to the direction of travel to carry the ring of pipe. By turning the rollers, the pipe was rotated so the joints could be placed at the bottom or top for the welding.

A start-and-stop plate was tacked to each end of each groove to allow the welding machine a 4-in. start before



GUYED DERRICK SERVES ASSEMBLY YARD
Trash Racks in Background and Penstock Tunnels at Right

SMALL SECTIONS IN THE YARD WERE HANDLED BY TRACTOR-DRAWN BOOM
Roller Beds for Assembling Sections in Center of Area

it actually began welding on the shell seam and 4 in. to stop on the other end. The start plates gave the operators a chance to get the machine in proper adjustment before it actually started welding on the joint. The stop plates were necessary to carry the very long puddle of molten metal past the end of the joint; if the welding were stopped at the end of the joint, the last few inches of weld would be neither uniform nor properly reinforced.

All three longitudinal joints were welded on the inside first, because it was easier to support them against distortion during welding when the joint being welded was directly on the bottom. Small hydraulic jacks were used, between the inclined roller ramp carriage and the pipe, to prevent distortion outward while the first, or inside, weld was being made. All three joints of the ring were welded inside before they were welded outside to minimize the moving of the welding head from bottom to top.

The welding head used was a carbon-arc machine, and all welding was covered up immediately by a flux that was fed automatically through a hopper onto the molten weld metal. The welder head was mounted on an arm, which could be moved up and down on a pipe mast to get the welding head above the penstock ring for doing the outside welding, or within the pipe for doing the inside welding. The welding head, arm, mast, hoist, and other equipment were all mounted on a special railroad car which could be moved back and forth on a railroad track.

As soon as the three longitudinal joints in a single ring were completely welded, the ring was lifted from the inclined roller carriage and placed on another roller bed where the longitudinal joints were radiographed. The main reason for radiographing these joints on the roller beds was to effect a minimum of moving and readjusting of the X-ray machine.

Here it is well to go into a little more detail on the radiographing and the equipment. The X-ray unit, complete with head, oil expansion tank, control panel, and the rest of the equipment, was mounted on a pneumatic-tired carriage, which could pass under the spider ring and through the penstock if the two bottom spider rods were removed. Since in radiographing a field joint it is desirable to have the X-ray head directly in the center of the pipe, the boom on the carriage was made long enough to put the head in the center of the pipe when the boom was in a vertical position. The boom was pin-connected at the bottom and was raised and lowered by means of a small hand windlass.

A system was set up to identify all radiographs as to where they originated. The four tunnels were given prefix numbers, 1, 2, 3, and 4, and each small ring of pipe in each tunnel was identified by a capital letter. The longitudinal joints in each ring were numbered 1, 2, and 3. The various exposures on each joint were also identified by number. All these identification marks were stenciled on the pipe prior to the exposure; then lead numbers and letters were placed over the stencils and held in place during exposure. When the radiographs were made, these lead numbers and letters recorded on the film, and as a result each individual piece of film could readily be traced. This system was very simple and proved quite satisfactory.

The dark room contained all the necessary equipment required to develop, fix, wash and dry, and examine the finished radiographs. Each hanger, containing two films that came out of the wash water prior to going into the drier, was placed before a large fluoroline illuminator. In the illuminator the two films were given a preliminary inspection for defects in the welding, and results were recorded on a special form showing the location and type of defects if any were present. This was done so that defects could be repaired while the film was drying, and in most cases the defective spots were repaired and reshot before the X-ray machine was moved to other work.

When the films were completely dry they were removed from the drier, placed in order, and put in the

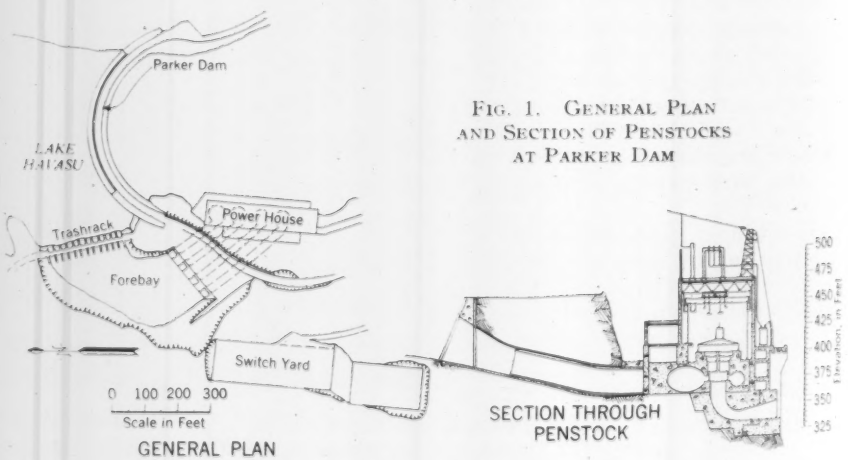


FIG. 1. GENERAL PLAN AND SECTION OF PENSTOCKS AT PARKER DAM

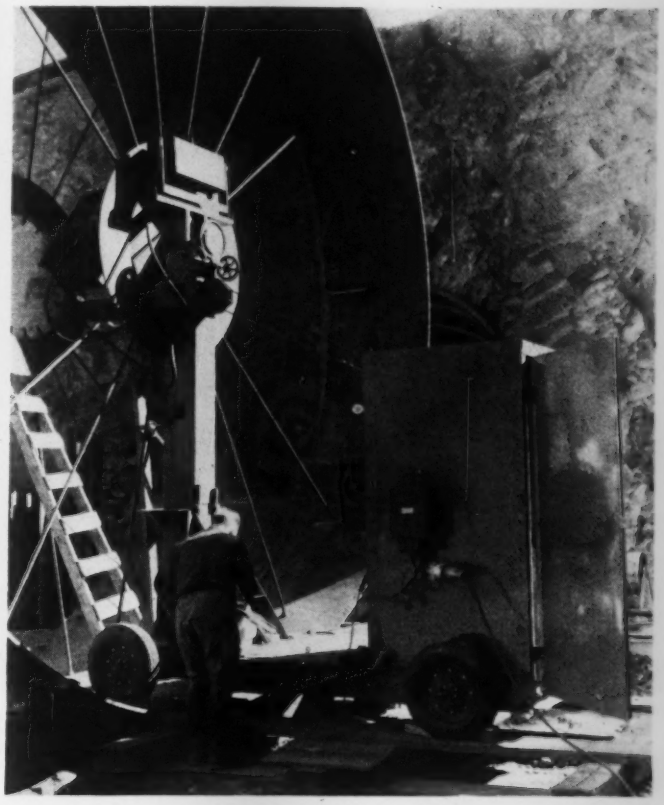
original black paper folders in which they were packed before exposure. Each one was carefully checked for defects and marked accordingly by the contractor. The radiographs were then examined by U.S. Bureau of Reclamation inspectors. Any defective films were marked on the charts and set aside until the time came when repairs could be made and acceptable radiographs obtained.

After the longitudinal joints were radiographed and accepted, the rings were lifted by the derrick and placed with their axes vertical. Locations of the stiffeners were marked on the ring by center punch marks, and then a fitting crew fitted the stiffener rings. The fitting crew was followed by welders, who welded the upper side of the stiffeners to the pipe. The derrick then turned these penstock rings completely over so the stiffeners could be welded on the other side. By this procedure it was possible to do all welding down hand and use large electrodes.

MACHINE WELDING OF CIRCUMFERENTIAL JOINTS

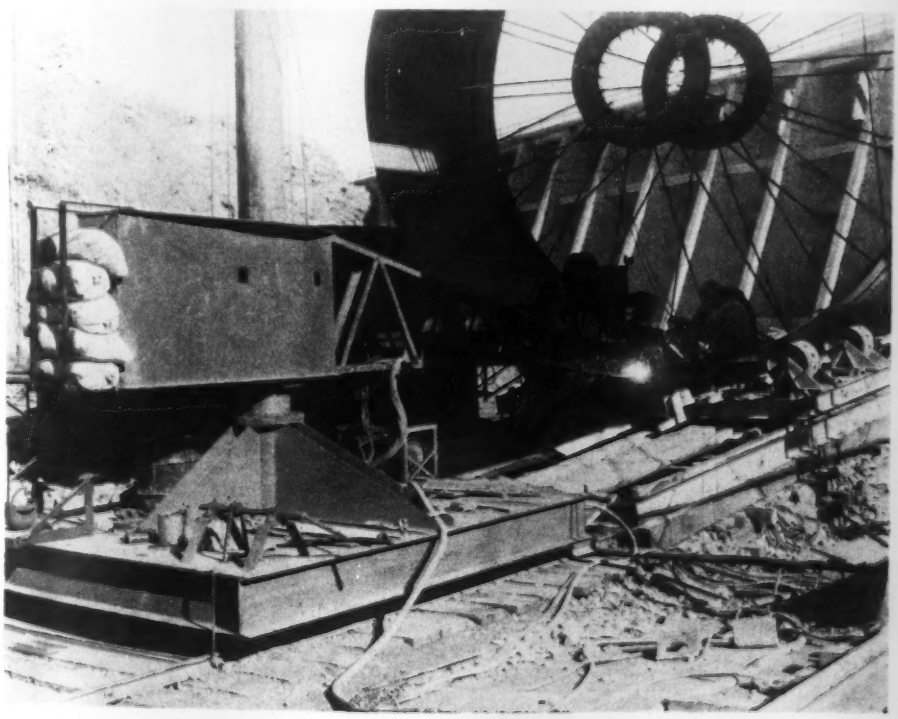
Each 10-ft ring had three or four stiffeners welded to it, and with these in place and completely welded, the rings had sufficient stiffness to be handled without spiders. The two spiders in every other ring of pipe were removed to allow the pipe to rotate while the automatic welder arm extended inside the pipe to weld the circumferential joint between the two single rings. The derrick then loaded two 10-ft rings, with their axes horizontal, onto a rubber-tired power-driven roller bed, where the two rings were fitted together. The ring without any spiders in it was facing toward the automatic welder arm and carriage.

The circumferential joint was automatically welded inside first and then outside, while rotating the pipe at the required speed for the welding. The specifications required that all welding be protected from the weather so a large rolling sunshade was erected. Its use resulted in very little time lost on account of bad weather. The shed rolled back out of the way on a track while the sections were loaded and unloaded from the automatic welding equipment.



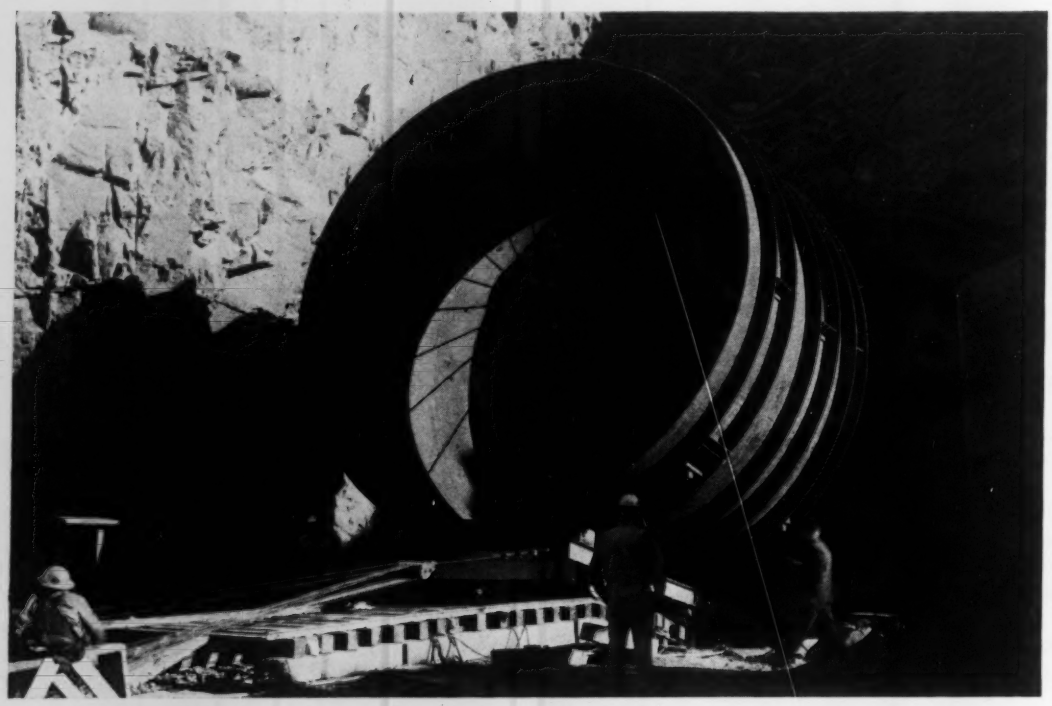
X RAY MACHINE IN POSITION TO INSPECT A CIRCUMFERENTIAL JOINT

After the circumferential joints were automatically welded in the assembly yard, the X-ray machine was put in position on the outside and the films were placed inside. The pipe was rolled, and the X-ray machine was stationary. By this procedure the thirty exposures of two films each were made in about one hour, the necessary repairs being made and the films reshot before the section was moved from the power-driven roller bed to the transfer car.



AUTOMATIC CARBON ARC-WELDING MACHINE
Inclined Carriage Controlled by Worm Drive Shaft

The penstock sections were set on screw jacks in the tunnel, held in line by horizontal screw jacks from the tunnel walls, and held down by screw jacks against the tunnel roof. These jacks fitted into sockets which were welded to large angles. The angles, in turn, were welded in between the stiffener rings around the penstock pipe. There were eight such fittings on each 20-ft section, each requiring a considerable amount of welding. After the automatic welding and radiographing were completed, these angles were tacked in place and most of the welding was done in the down-hand position. The welds were put into position by rotating the pipe on the roller bed. It was economical to do the welding in this manner, using large



PENSTOCK SECTION BEING LOWERED INTO TUNNEL
When Complete Penstock Was in Place and Welded, Concrete Backfill Was Added

electrodes—even though this method usually tied up the power-driven roller bed for one shift for each section.

CARS PLACE PENSTOCK SECTIONS

A wide-gage transfer car was made to suit the requirements for hauling these pipe sections from the forebay down through the tunnels into place. The railroad was constructed to grade and line all the way down the tunnel so that when the section arrived on the transfer car it would be directly in line and about 1 in. low. When the pipe section was raised to grade with the aid of the temporary hydraulic and permanent screw jacks, there was about 1 in. of space between the car and the pipe which allowed the transfer car to come out easily.

With the aid of the screw jacks and the small hydraulic jacks, each section of pipe was set for rotation, line, and grade, and held there by fitting the joint and setting all jacks. The welding of the field joints in the tunnel was done manually with two operators on each joint. The welding procedure on one field circumferential joint was the direct opposite of that used on the next adjacent field joint as far as starting points and direction of welding were concerned, so that the over-all shrinkage of the penstock would be equal in all quadrants.

To minimize moving the X-ray machine, an effort was made to get a week or two ahead with the radiographing in the assembly yard at about the same time all the field welding was completed in a penstock. The machine was then taken into a penstock and, starting at the joint on the upstream end, each circumferential field joint was radiographed. No effort was made to pick up reshots at that time; however, repairs were made immediately after the radiographs were developed. By the time the radiographing on the last field joint downstream was completed and the defects repaired, the machine was moved back upstream in order to get reshots. By the time the machine reached the upstream end of the penstock, the radiographing that was to be done in that penstock was usually completed.

After the concrete backing was placed between the penstocks and the tunnels and given time for its initial set, the remaining inside spiders were taken out of the penstock and the nuts chipped off, leaving the inside smooth.

At the start of the job all operators, both machine and manual, were required to make test welds. The results of the physical tests on each weld had to be satisfactory before the operator making the test was qualified to work on the penstocks. At regular intervals throughout the job representative test welds were made by both machine and manual welding. All test welds were given physical tests, the results of which had to equal the requirements of the U.S. Bureau of Reclamation before they were acceptable.

The work was carried on for the Bureau of Reclamation under the direction of E. C. Koppen (deceased), Construction Engineer, and his assistant, J. A. Fraps, Assoc. M. Am. Soc. C.E. Mr. Hugh L. P. Stewart, engineer for the Bureau, and his assistant, E. Craig, supervised the actual penstock erection. Contract for fabricating and erecting the penstock lining was held by the Chicago Bridge and Iron Company.

INTERIOR OF PENSTOCK TUNNEL
Steel Lining Was Brought into Place by Carriage and Anchored to Pedestals Provided

The Design of Recent TVA Projects

VII. Chatuge and Nottely Projects

By M. L. Dickinson

Project Engineer, Tennessee Valley Authority

LOCATED on the upper watershed of the Hiwassee River, the Chatuge and Nottely projects are secondary tributary storage developments, as classified in the initial article of this series (March Civil Engineering). *The stored water will add 60,000 kw of firm power in seven existing and two nearly completed downstream plants of the TVA system. As explained by Mr. Dickinson, these projects are well adapted to postwar conditions of multi-purpose operation, providing storage for dry years and flood control benefits for wet years.*

CONGRESS in July 1941 authorized the Chatuge and Nottely projects as part of the Second Emergency Power Program for National Defense. The deciding factor favoring inclusion of these developments in the emergency program was their ability to create a substantial block of additional power in the system without waiting for the manufacture of complicated generating equipment. Together they provide 400,000 acre-ft of controlled storage upstream from Hiwassee Dam. To realize this advantage, however, it was essential that the reservoirs be completed and ready for storing water by the next high-flow season. This required an unprecedentedly fast design and construction program, authorization of the project in July necessitating closure only six months later.

Since only sufficient investigation and planning had been done to prove the feasibility of the sites and to determine the general types of dams and heights that would be desirable, it was necessary to complete field exploration, prepare working designs, and carry out construction operations in an extremely short period. By using all the resources of a seasoned organization, completion of the projects—involving approximately 600,000 cu yd of excavation, 4,000,000 cu yd of earth-and-rock fill, and 40,000 cu yd of reinforced concrete—was effected to permit closure at Nottely on January 24, 1942, and at Chatuge on February 12, 1942.

The urgency for completing these jobs to make additional power for national defense available as soon as possible and the necessity for constructing them with a minimum use of critical materials and heavy equipment greatly influenced the layout and design of the various structures at both projects. The availability of construction equipment from other projects of the Tennessee Valley Authority and the most efficient use of native materials dictated that both dams should be of the embankment type. These same factors, coupled with topographic conditions at the sites, necessitated unusually close coordination of construction with river diversion and thus also influenced both the design and construction plan. In order to expedite design, manufacture of equipment, and construction work and, at the same time, to realize substantial economies, full advantage was taken of duplication of design at the two projects wherever possible.

CHATUGE PROJECT

Chatuge Reservoir is on the Hiwassee River and straddles the Georgia–North Carolina state line, extending about equally into both states. It has a drainage area of 189 sq miles and a total controlled storage volume of 243,000 acre-ft, of which 226,000 acre-ft—representing approximately 60% of the average yearly runoff—is useful.

The dam (Fig. 1) is located in rolling mountainous country at a site where the hills protrude into the flood plain of the valley from both sides. The topography of the dam site is relatively flat, especially along the right abutment where the ground surface is below reservoir level for a distance of over 1,400 ft, requiring a long embankment. Overburden was comparatively shallow over the flood plain on the left abutment, but became very deep along the flatter right abutment, making it impracticable to excavate to a rock foundation. Adequate borrow pits of an impermeable clay were available close to the dam both upstream and downstream of the site.

A quarry site, expected to yield ample rock for riprapping, was available at a reasonable distance but could not be depended upon to furnish the amount of rock required for a rock-fill structure. These factors definitely indicated a full rolled earth fill as being most desirable for the site, the embankment having a total volume of 2,300,000 cu yd, a length of 2,850 ft, and a maximum height of 140 ft. It was found that three small earth dikes would also be required in adjacent saddles below maximum pool level.

The flat topography at the Chatuge site provided an immediate working area on both abutments, permitting over half the entire fill to be placed before the river was diverted. This same condition precluded use of a diversion tunnel and required that the river be diverted by some form of low-level conduit. To accomplish this a concrete arch culvert was constructed along the right river bank simultaneously with the placing of rolled fill on both abutments. Upon completion of the culvert, the river was diverted through it, and the remaining plug section of embankment was constructed over the culvert and the original river bed. After closure, the diversion culvert was converted into part of the permanent control works by installing a penstock leading through the culvert from the intake tower at the upper end to a regulating discharge valve at the outlet.

Air View Showing Construction of Main Embarkment Spillway, and Intake Tower at Nottely Dam

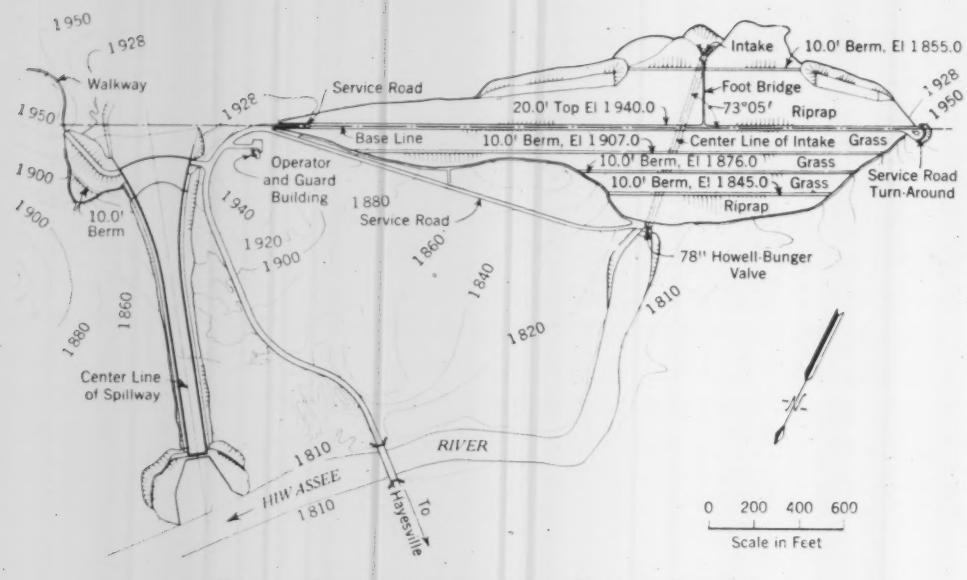


FIG. 1. GENERAL LAYOUT OF THE CHATUGE PROJECT
Spillway at Left Directs Overflow Downstream to Avoid Undermining Structures

A saddle just beyond the right abutment of the main embankment offered favorable conditions for a chute-type overflow spillway. This spillway consists of a curved-crest weir converging to a long chute section which extends to the river bank.

NOTTELY PROJECT

Nottely Reservoir is located in Georgia on the Nottely River about 21 miles above its confluence with the Hiwassee River. The reservoir has a controlled storage of 190,000 acre-ft, practically all of which is useful. This is equivalent to about 60% of the average annual runoff from the 215-sq-mile drainage area.

The dam site is a rugged mountain gorge with abutments rising steeply from the narrow flood plain. Overburden was shallow except on the long low extension along the ridge at the top of the left abutment. Excellent impervious borrow in adequate quantity was available a short distance upstream, while rock quarries of almost unlimited yield were available in the downstream area. In view of these sources of material and the influence of type of dam on the diversion and outlet works, preliminary estimates showed very little difference in cost between an earth and an earth-and-rock dam. However, the time element, construction risks, and available equipment all favored construction of a combination earth-and-rock embankment.

It was decided that though abnormally heavy rains might impede the progress of construction of a rolled earth fill, they probably would not seriously delay placing of the smaller amount of earth in an earth-and-rock structure. Also, the steeper embankment slopes of the rock section would permit use of a shorter diversion tunnel, thus reducing the time until the river could be diverted and decreasing the risk of delay from this source. Furthermore, the combined earth-and-rock section would be less subject to damage from overtopping during construction by floods of unforeseen magnitude. And finally, since Chatuge Dam was to be an earth-fill structure, the availability of construction equipment made it desirable to limit the amount of earth fill required at Nottely. The combined earth-and-rock structure decided upon has an impervious rolled earth core supported on both sides by rock fill, the embankment having a length of 2,305 ft and a maximum height of 190 ft, and containing 840,000 cu yd of earth and 700,000 cu yd of rock fill.

The narrow canyon and steep slopes at Nottely required that river diversion be accomplished by a tunnel through the left abutment. However, these topographic conditions prevented placing of any appreciable quantity of fill until the river was diverted from its original bed. A temporary open diversion channel was therefore cut into the base of the hill along the right bank, making it possible to place more than half the fill over the river bed and the left abutment while the tunnel was being driven. When construction of the tunnel was completed, the river was rediverted into it, and the remaining plug section of fill was placed over the first-stage diversion channel and the right abutment. The diversion tunnel was converted into a permanent outlet conduit by installing a steel-plate liner section in the downstream end after the bulkhead gates in the intake tower were closed.

An overflow chute spillway, similar to the one at Chatuge Dam, cuts through the low embankment along the ridge forming the left abutment. A public highway which crosses Nottely Dam is carried on a bridge across the spillway approach just upstream from the weir crest.

Approximate principal construction quantities for the two projects are given in the following tabulation:

	CHATUGE	NOTTELY
Excavation	386,000 cu yd	209,000 cu yd
Rolled earth fill	2,220,000 cu yd	837,000 cu yd
Rock fill and riprap	131,000 cu yd	698,000 cu yd
Concrete	24,500 cu yd	13,600 cu yd
Reinforcing	1,320 tons	910 tons
Metal work	980 tons	840 tons

DESIGN OF EMBANKMENT SECTIONS

Chatuge Dam site was investigated by drill holes and test pits which showed the overburden to vary in depth from 2 to 15 ft on the left abutment, while on the right abutment it reached a depth of over 30 ft. The underlying rock consists principally of interbedded layers of schist and gneiss, although frequently no definite line between overburden and rock was found, the material gradually changing from completely weathered to sound rock. Shear tests on the undisturbed overburden indicated an internal friction angle of about 26°, while tests in the borrow-pit areas showed that the rolled material would also have a safe angle of internal friction of 26° and a safe cohesion of 500 lb per sq ft. Overburden and borrow pit materials were essentially uniform and quite impervious.

Based on these tests, the final embankment sections (Fig. 2) were designed, by the conventional slip-circle method, to obtain a factor of safety of 1.3 at the upstream slope for sudden drawdown conditions and a factor of safety of 1.5 at the downstream slope for maximum operating conditions. In order to obtain this factor of safety on the upstream slope for high sections of the dam, it was necessary to excavate the low-cohesion overburden from the upstream quarter of the foundation and to replace it

NOTTELY DAM SPILLWAY. NOTE OUTLET VALVE HOUSE AT BASE OF DAM AT LEFT CENTER AND INTAKE TOWER PROJECTING ABOVE DAM AT UPPER LEFT

with rolled material. A low concrete cutoff wall is keyed into rock near the downstream edge of this excavated section. Along a portion of the right abutment, where the overburden became too deep for economical excavation and replacement, the toe is strengthened to give approximately equal safety by placing an impervious rolled fill blanket along the upstream toe.

Where the embankment is less than 40 ft in height, neither excavation nor blanket was necessary. Since the entire section is constructed of uniformly impervious material and since it was desired to obtain the factor of safety at the downstream slope, it was necessary to control the saturation line by internal drainage, consisting of a drain blanket placed on top of the natural ground over approximately the middle third of the downstream half of the foundation. This drain blanket is constructed of fine, fairly pervious, natural sand excavated from the flood plain, and is connected by drain pipes to a rock-filled trench along the downstream toe.

The top of Chatuge Dam is set at El. 1,940, which is 12 ft above maximum controlled headwater level, the 20-ft-wide crest containing a 10-ft maintenance road. The upstream slope above minimum pool level and the downstream slope below maximum tailwater level are riprapped for protection against washing, while the downstream slope above the riprap is seeded to prevent erosion. Berms 10 ft wide at vertical intervals of 30 ft on the downstream slope collect surface drainage, which is then carried through pipes to the toe trench.

The design of Nottely Dam was carried out by methods similar to those used for Chatuge Dam. For sections having a height of more than 90 ft, all overburden was removed under the entire rock fill and under the upstream half of the earth core, and a low cutoff wall was constructed just upstream from the center line. A drainage blanket, composed of natural sand excavated from the river bed, was placed on top of the overburden under the downstream quarter of the earth fill in order to keep the saturation line entirely within the core. A transition section, which necessitated increasing the width of the upstream berm, was used near the top of the left abutment where the overburden was too deep for economical excavation. In this section the entire earth fill was placed on overburden, the cutoff wall omitted, and a rolled clay blanket provided against the upstream slope of the undisturbed overburden.

For dam sections less than 30 ft in height the entire base of both earth and rock fill was placed on the existing earth foundation, additional berm widths being added both upstream and downstream to provide adequate stability. On all sections of the dam, the rock shoulders upstream and downstream have an average slope of 1 on 2. This average is economically obtained by using an actual natural slope of 1 on 1.4 with 18-ft-wide berms at 30-ft heights. Filter blankets are used between the earth and rock on both slopes to prevent the finer core material from being washed into the rock. The upstream blanket is thicker and of more elaborate construction to resist the greater severity of the water action.

The crest of the dam is set at El. 1,794, and has a 14-ft freeboard above maximum controlled headwater level. The berms near the top of the dam are narrowed to 12 ft in order to provide a 32-ft crest width on which is carried a public highway 20 ft wide.

CONTROL WORKS

Low-level outlets (Fig. 3) are used at each project for the release of stored water during low-flow seasons. The intake towers for both projects are essentially identical except for height, and consist of cylindrical shafts having an inside diameter of 25 ft and extending the full height of the reservoir. A trash-rack structure extends upstream from each tower over the waterway entrance. Two 5-ft 8-in. by 10-ft 0-in. slide gates, operated by oil pressure, are arranged side by side in the base of each tower to permit closure of the pressure conduit for inspection and maintenance. Since it was not possible to secure delivery of the permanent slide gates before diverting the rivers through the conduits, special bulkheads were job-fabricated to close the openings.

These bulkheads consisted of steel frames covered with heavy timber sheathing and contained sliding steel panels which could be opened in case of necessity to prevent the reservoirs from filling faster than desired. A 15-ton service crane for handling the trash-racks, bulkheads, and slide gates is installed in the overhanging crane house which tops off the tower. Each tower contains a headwater gage well with electrical transmitting equipment that connects to an indicating and recording instrument located in the service building. A light footbridge connects the tower with the crest of the embankment. Heavy materials must be handled from a barge through a hatch opening in the floor of the overhanging portion of the crane house.

It did not prove economical to design the Chatuge outlet culvert as a pressure conduit large enough for the desired diversion capacity and strong enough to withstand the ultimate penstock pressures. It was therefore decided to use a culvert designed to support the external earth-fill loads only and to install a penstock line inside the culvert after closure. The resulting parabolic arch reinforced-concrete culvert, 26 ft wide and 17 ft high, is somewhat larger than was required for diversion only, having a capacity of 10,000 cu ft per sec with a 50-ft depth at the intake—equivalent to about

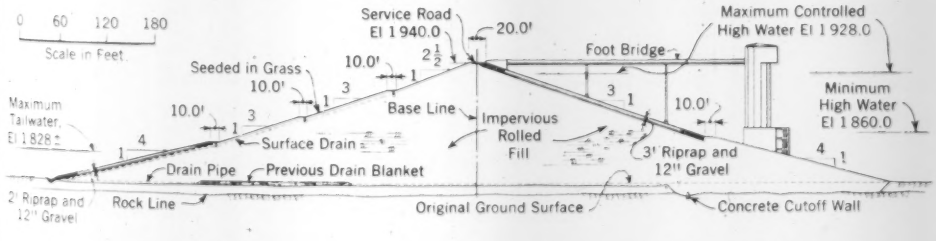


FIG. 2. SECTION THROUGH CHATUGE DAM AT POINT OF MAXIMUM EMBANKMENT

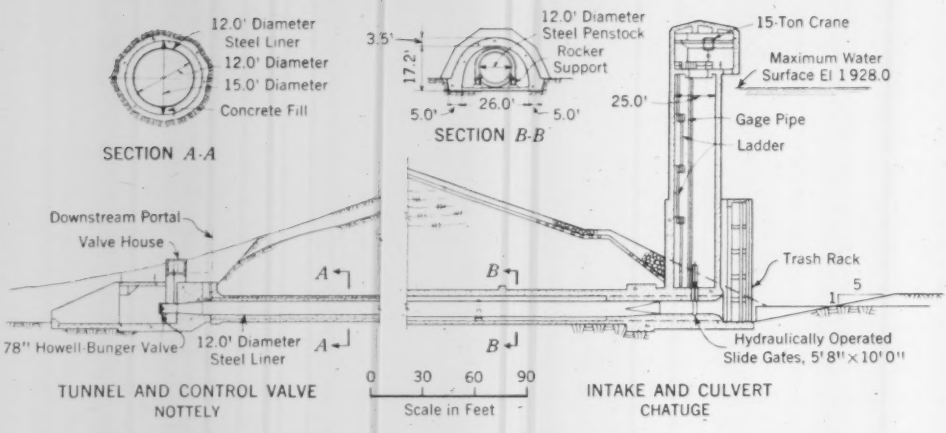


FIG. 3. CONTROL WORKS SECTION AT CHATUGE AND NOTTELY PROJECTS

the 19-year flood to be expected during the July to December construction period.

To prevent seepage along the outside of the culvert, three concrete cutoff collars were poured around the arch, and recessed keys were spaced throughout the full length in order to secure good contact with the earth fill. The steel penstock 12 ft in diameter has a future capacity of about 1,550 cu ft per sec for power generation and is designed for full maximum static pressure plus water hammer. The penstock is of welded construction freely supported at 73-ft centers on ring supports having rocker bases, the line being anchored into concrete at both ends with an expansion joint near the downstream end.

At Nottely it was found feasible to construct the diversion tunnel to carry the ultimate internal pressures required, the adopted lined section 15 ft in diameter being the best size to satisfactorily accomplish both the temporary and the ultimate purposes. During the construction period it had a diversion capacity of 5,000 cu ft per sec for a 50-ft head on the intake, this being about equal to the flood to be expected once in 5 years. After closure, a welded steel liner 12 ft in diameter was concreted into the downstream end of the tunnel, where the depth of cover and the rock conditions were considered insufficient to withstand the ultimate penstock pressures.

The outlet structures for the conduits are nearly identical, each consisting of a control valve house and a stilling basin. The stilling basins were constructed prior to river diversion to protect the structures against scour during this period; but the valve houses were not built until after closure of the dams, at which time the penstock or tunnel liner and the regulating valves were also installed. Each of these control valves is designed to discharge about 1,500 cu ft per sec under minimum headwater conditions and about 2,000 cu ft per sec under average head. This required a 78-in. valve at Chatuge and only a 72-in. valve for the higher head at Nottely, but actual bid prices showed a saving by using identical valves of the 78-in. size for both projects. The Howell-Bunger valves selected are essentially cylinder-type valves set horizontally with an outside sliding sleeve seating against a fixed conical downstream end section. An 18-in. auxiliary gate valve is installed in a by-pass line to release small flows. The stilling basin downstream from the valve is built to contain completely the conical-shaped jet issuing from the valve.

DESIGN OF SPILLWAYS

The two watersheds are similar, both being located in mountainous regions varying in elevation from the dam site to about 4,000 ft. Both are relatively heavily timbered, and both have an average annual precipitation close to 60 in. Spillway capacities were based upon studies of actual flood hydrographs and assumed possible storms reaching a peak inflow approximated by the formula $Q = 6{,}000\sqrt{A}$. For the 189-sq-mile drainage area at Chatuge, this results in a maximum flood inflow at 83,000 cu ft per sec, while the maximum inflow rate is 88,000 cu ft per sec for the 215-sq-mile drainage area at Nottely. Assuming the reservoirs full at the start of the flood, it was determined that these inflows would be reduced by reservoir surcharge storage to a maximum spillway discharge of 39,000 cu ft per sec at Chatuge and 48,000 cu ft per sec at Nottely.

The spillways for the two projects also permitted considerable duplication in design, each having a curved crest 325 ft long converging to a chute section 80 ft wide. The Chatuge spillway is 1,350 ft in length and ends with a 30° sill 5 ft high on a rock ledge at the river bank about 25 ft above stream bed. Nottely spillway is 620 ft long and terminates in a "ski-jump" outlet structure on the rock bluff some 60 ft above the river bed.

HYDRAULIC LABORATORY MODEL TESTS USEFUL

Since both spillways were to be constructed largely on earth foundations, it was decided to use long crests with a comparatively low depth of overflow. The proposed operating scheme for both reservoirs indicated that control of the discharge would not ordinarily be necessary, as it was planned to operate them as fixed-crest overflow spillways during the flood season. These circumstances made it uneconomical to provide an elaborate system of crest gates, and it was decided to use simple flashboard control. Ordinarily it is expected that the flashboards can be placed one course at a time above pool level and allowed to remain in place until the reservoir is again drawn down below the crest. However, in order to make it possible to remove flashboards in an emergency, two simple traveling hand hoists are provided to operate along the spillway footbridge at each location.

Extensive use of hydraulic laboratory model tests was made in the design of the spillways. These tests indicated that, in order to establish a smooth transition in the flow from the wide entrance to the much narrower chute section, the spillway should have a curved crest and a transition section with long radius curved side wall gradually converging to the chute. A conical surface was found to be the most satisfactory shape for the transition floor, all radial sections sloping uniformly from the crest toward the center until they intersect the plane surface of the lower portion. The coefficient of discharge for the weir under maximum head was found to be about 3.7 for Chatuge and 3.85 for Nottely. Much attention was also given to tests of the outlet structures, where the discharge leaves the chute at a high velocity. The outlets were designed to direct the jets sufficiently far downstream to insure that the structures would not be undermined by the unavoidable scour at the bottom of the waterfall. This type of outfall structure avoided the necessity for expensive stilling basins constructed of concrete.

Compact Sewage Treatment Works Units at Cranston, R.I.

Modern Plant Effects Complete Treatment of Municipal Sewage

By RALPH W. HORNE, M. AM. SOC. C.E.
PARTNER, FAY, SPOFFORD AND THORNDIKE, BOSTON, MASS.

A NEW plant, designed to treat 5½ million gallons of sewage per day, enables Cranston, R.I., to effect complete treatment at an operating cost of about $23 per million gallons. One of the unusual features of this new plant is the use of an auxiliary plant water supply for sludge elutriation, which saves $5,000 a year in the purchase of water. Mr. Horne presented an expanded form of this paper at a recent meeting of the Providence Section of the Society.

ALTHOUGH the City of Cranston, R.I., began as far back as 1923 to consider the matter of installing modern sewerage facilities, it was not until November 1938 that the project approached reality. At that time the federal government approved an application to the Work Projects Administration for the undertaking, and offered federal assistance to the extent of about $3,500,000 toward the project, which it was estimated would require a total of nearly $6,000,000.

Construction work began June 5, 1939, the WPA organization and city forces working jointly on the project, one of the largest of its kind undertaken by the WPA. The entire project includes nearly 96½ miles of gravity sewers; about 3½ miles of force main sewers; over 40 miles of sewer service connections; 7 sewage pumping stations, with designed capacities from 400 to 7,300 gal per min; and a complete sewage treatment works.

The construction of pumping station superstructures and the installation of pumping station equipment, as well as the entire construction of the sewage treatment works, were by contract; all other work was undertaken by the WPA and city forces working together. In September 1942, the WPA withdrew completely from the project, and the work was then carried on by city forces alone. It was predicted by the WPA that construction would be at the average rate of 850 ft of sewer per working day; the actual rate accomplished averaged 335 ft per working day up to the time when the WPA withdrew.

All the city's sewage collects at a main sewage pumping station, designated the Pontiac Avenue pumping station, from which it is delivered through about 3,000 ft of 24-in. force main sewer to the sewage treatment works. The treated sewage discharges into the Pawtuxet River about 4 miles above where the river enters Narragansett Bay.

The sewage treatment works includes units for primary treatment to remove grit, grease, and settleable solids; units for secondary treatment by the activated sludge process; units for disposal of sludge by digestion, vacuum filtration, and incineration; and an operating building. The plant was designed to have a capacity adequate for estimated rates of flow in 1950—namely, an average daily rate of about 5.5 million gal per day and a maximum daily rate of about 7.7 million gal per day. The arrangement of the several units that comprise the treatment works and the normal sequence of operations are shown on the accompanying flow diagram (Fig. 1).

Sewage first enters the grit-removal unit, where grit and other relatively heavy solids are separated from the liquids by sedimentation. This unit is a shallow concrete basin about 18 ft across with an effective depth of about 1 ft 3 in. below the crest of the overflow weir. Mechanical equipment includes a revolving detritor 18 ft in diameter driven by an electric motor, a reciprocating raking device, and a propeller-type pump. Grit and other solids are mechanically raked from a sump at one side, up an inclined cleaning channel, and removed for disposal. Stagnant sewage in the cleaning channel is pumped back into the stream of incoming sewage.

Next the sewage is passed through a comminution unit consisting of two channels, each about 5 ft wide and 5½ ft deep. In one channel there is installed a 25-in. comminutor mechanism, and in the other an inclined fixed-bar screen. The comminutor cuts and shreds the solids, reducing them to a size that will pass through slots ⅜ in. wide. Provision has been made for installing a second comminutor mechanism in the future to replace the fixed-bar screen.

A master venturi-type meter measures all sewage passing through the treatment works. This is installed in a concrete chamber about 24 ft long by 8 ft wide by 12 ft deep. A connection at the outlet end of the meter permits the sewage to be dosed with chlorine just before it enters the grease-removal unit.

GREASE REMOVED BY AIR DIFFUSION

A single unit is provided for the removal of grease and fats from the sewage liquids. This consists of a concrete tank about 20 ft square with a side-water depth of 10 ft 4 in. and a mechanical flotation device. Separation of grease and fats is accomplished by diffusing over the bottom of the unit finely divided air particles which, in rising upwards to the surface of the liquid, carry with them the particles of grease and fats. Grease accumulating on the surface is drawn into troughs at both sides of the tank by means of revolving spiral rubber squeegee strips.

After leaving the grease-removal unit, the sewage goes to two primary settling tanks. Each tank is of concrete, 50 ft square, with side-water depth of 9 ft 1 in. The bot-

GRIT REMOVAL AND COMMINUTION UNITS

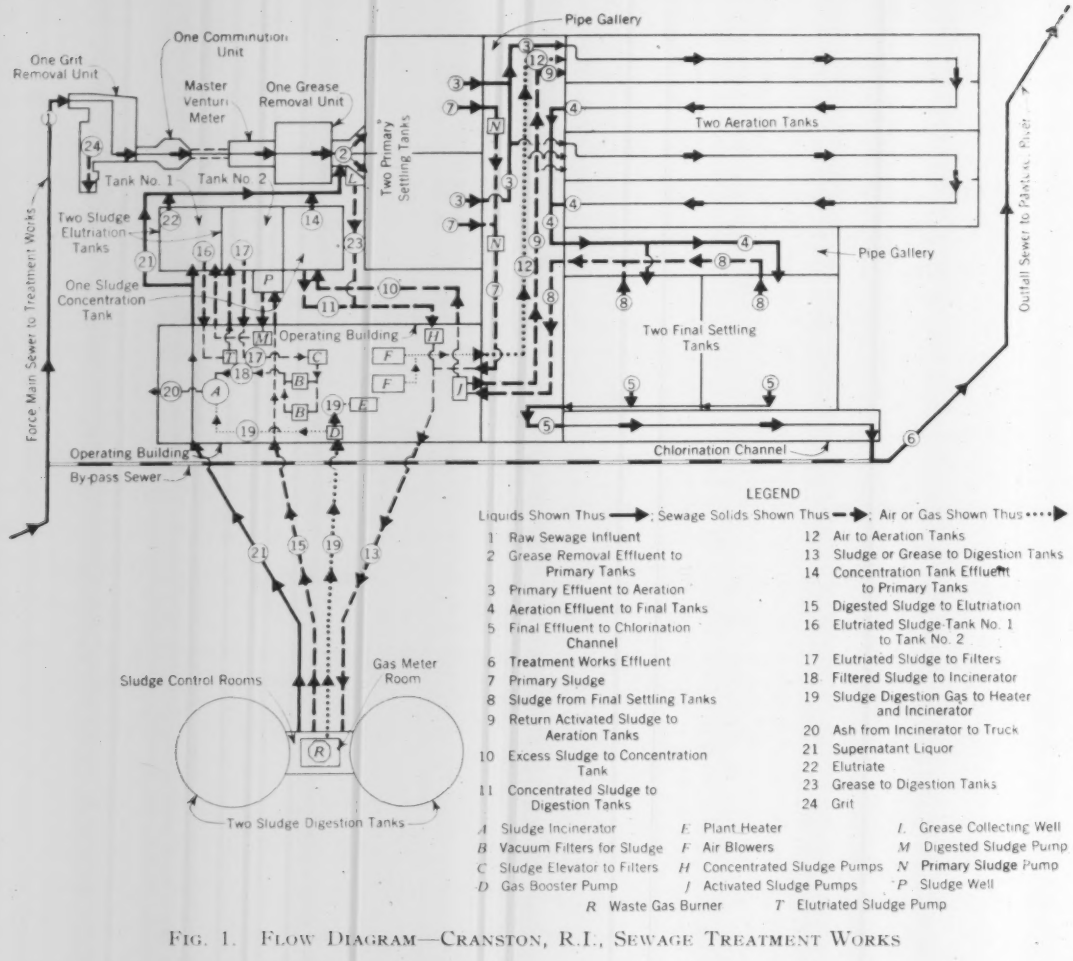

Pipe Gallery
One Comminution Unit
One Grit Removal Unit
Master Venturi Meter
One Grease Removal Unit
Two Primary Settling Tanks
Two Aeration Tanks
Tank No. 1
Tank No. 2
Two Sludge Elutriation Tanks
One Sludge Concentration Tank
Pipe Gallery
Outfall Sewer to Pawtuxet River
Force Main Sewer to Treatment Works
Operating Building
Two Final Settling Tanks
Operating Building
By-pass Sewer
Chlorination Channel
Sludge Control Rooms
Gas Meter Room
Two Sludge Digestion Tanks
LEGEND
Liquids Shown Thus ——▶; Sewage Solids Shown Thus ——▶; Air or Gas Shown Thus ····▶
1 Raw Sewage Influent
2 Grease Removal Effluent to Primary Tanks
3 Primary Effluent to Aeration
4 Aeration Effluent to Final Tanks
5 Final Effluent to Chlorination Channel
6 Treatment Works Effluent
7 Primary Sludge
8 Sludge from Final Settling Tanks
9 Return Activated Sludge to Aeration Tanks
10 Excess Sludge to Concentration Tank
11 Concentrated Sludge to Digestion Tanks
12 Air to Aeration Tanks
13 Sludge or Grease to Digestion Tanks
14 Concentration Tank Effluent to Primary Tanks
15 Digested Sludge to Elutriation
16 Elutriated Sludge Tank No. 1 to Tank No. 2
17 Elutriated Sludge to Filters
18 Filtered Sludge to Incinerator
19 Sludge Digestion Gas to Heater and Incinerator
20 Ash from Incinerator to Truck
21 Supernatant Liquor
22 Elutriate
23 Grease to Digestion Tanks
24 Grit
A Sludge Incinerator
B Vacuum Filters for Sludge
C Sludge Elevator to Filters
D Gas Booster Pump
E Plant Heater
F Air Blowers
H Concentrated Sludge Pumps
J Activated Sludge Pumps
R Waste Gas Burner
L Grease Collecting Well
M Digested Sludge Pump
N Primary Sludge Pump
P Sludge Well
T Elutriated Sludge Pump

FIG. 1. FLOW DIAGRAM—CRANSTON, R.I., SEWAGE TREATMENT WORKS

tom slopes toward a central sump, the slope being one inch per foot. Mechanical equipment for each tank consists of a revolving center-drive clarifier having two bottom scraper arms with blades and a skimmer arm at flow-line level. Sewage enters the tanks at the bottom through a cast-iron pipe, which discharges at a central influent well. The sludge is pumped from the tanks several times each day to sludge-digestion tanks.

From the primary settling tanks the effluent passes to the two aeration tanks, in which the sewage liquids are thoroughly mixed with returned activated sludge by means of compressed air discharged through air diffuser tubes placed near the tank bottoms. Each tank is about 210 ft long by 41 ft wide, with side-water depth of 12 ft, and is divided into two longitudinal channels (or passes), each 20 ft wide. Each tank is equipped with 338 air-diffuser tubes of tear-drop shape. Each is 2 ft long, spaced for tapered aeration, and connected to a cast-iron header pipe.

The primary tank effluent, the returned activated sludge, and the air supply all enter the aeration tanks near the bottom in a corner at the inlet end. Compressed air for the aeration tanks is furnished by two rotary-type positive displacement blowers. Each blower has two sets of rotary impellers, one set having a capacity of 1,500 cu ft per min and the other of 2,500 cu ft per min—a total capacity of 4,000 cu ft per min when both impellers are operating together.

The effluent from the aeration tanks passes to the two final settling tanks, which are 60 ft square, with side-water depths of about 9 ft 10 in. Mechanical equipment consists of revolving center-drive clarifiers with two bottom rake arms and scraper blades. Sewage enters the tanks through an influent trough discharging at flow-line level at the center of the tanks. Sludge collected in these tanks furnishes the return activated sludge for the aeration tanks. Excess sludge is thickened in a sludge concentration tank and then pumped to the sludge digestion tanks.

EFFLUENT CHLORINATED

Effluent from the final settling tanks flows through a chlorination channel, where it is disinfected before passing from the treatment works into the outfall sewer, and thence to the Pawtuxet River. This channel is 121½ ft long by 6 ft 6 in. wide and has an effective depth of about 5 ft.

The major piping that conveys the effluents between the primary settling tanks, aeration tanks, and final settling tanks, as well as the compressed air piping, the return activated sludge piping, and other miscellaneous piping, is housed in two pipe galleries. Provisions for sampling sludge from both the primary and final settling tanks have also been installed in the pipe galleries.

Excess activated sludge, not returned to the aeration tanks from the final settling tanks, is thickened in a sludge concentration tank in order to reduce its moisture content. This tank is 26 ft square with side-water depth of 9 ft 10 in., the bottom sloping to a central sludge pocket. It is equipped with a revolving center-drive sludge-thickening mechanism consisting of two bottom arms with scraper blades and vertical pickets. Liquid effluent from the tank is again mixed with the sewage liquids entering the primary settling tanks. Thickened sludge is pumped to the sludge digestion tanks.

THESE FINAL SETTLING TANKS COLLECT ACTIVATED SLUDGE FOR USE IN AERATION TANKS

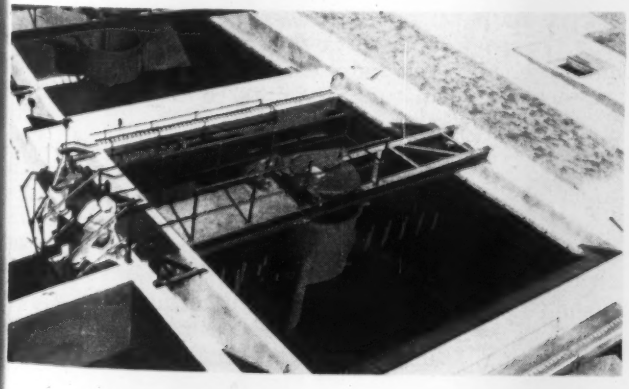
There are two sludge digestion tanks in which anaerobic digestion of the sludge is accomplished. Each tank is 50 ft in diameter with effective side depths of 26 ft and effective center depths of 31.5 ft. Each is equipped with a floating cover for collecting the gas produced. The tanks are heated by eight 4-in. lines of hot water piping placed around the inside perimeter to maintain sludge temperatures up to 95°. Digested sludge is withdrawn from the tanks through pipes extending from the hopper bottom in the center. Supernatant liquor is withdrawn at various levels by means of pipes through the vertical walls of the tanks. Gas collected under the floating covers of the tanks is used either for heating the tanks and operating building or for incineration of the sludge; otherwise, it is burned as waste gas.

AERATION TANKS—SLUDGE DIGESTION TANKS AND OPERATING BUILDING IN BACKGROUND

Between the two sludge-digestion tanks there is a building structure housing two sludge control rooms—one above the other—a gas meter room, and a waste gas burner. Piping and valves for controlling the flow of sludge are in the two former rooms, while the gas meter room houses facilities for measuring and controlling the flow of gas produced. Excess gas is burned in the waste gas burner, which is enclosed by a chimney located on the roof of the gas meter room. Various precautions have been taken to guard against the danger of explosion in both the gas meter room and the sludge control rooms.

SLUDGE WASHED IN ELUTRIATION TANKS

Digested sludge is withdrawn from the sludge digestion tanks into a sludge storage well, whence it is pumped to sludge elutriation tanks. The sludge is washed, by means of the Genter counter-current elutriation process in two elutriation tanks, in order to reduce the quantity of ferric chloride needed to produce the best dewatering results from vacuum filtration. Each tank is 26 ft square with side-water depth of from 10 to 11 ft, and sloping bottoms. Mechanical equipment in each consists of a revolving center-drive sludge-thickening mechanism fitted with bottom scrapers and vertical pickets. In the elutriation tanks, which are operated in series, the digested sludge is thoroughly washed by being mixed and stirred with clean water and elutriate in the proportion of about 3 parts to one part of sludge.

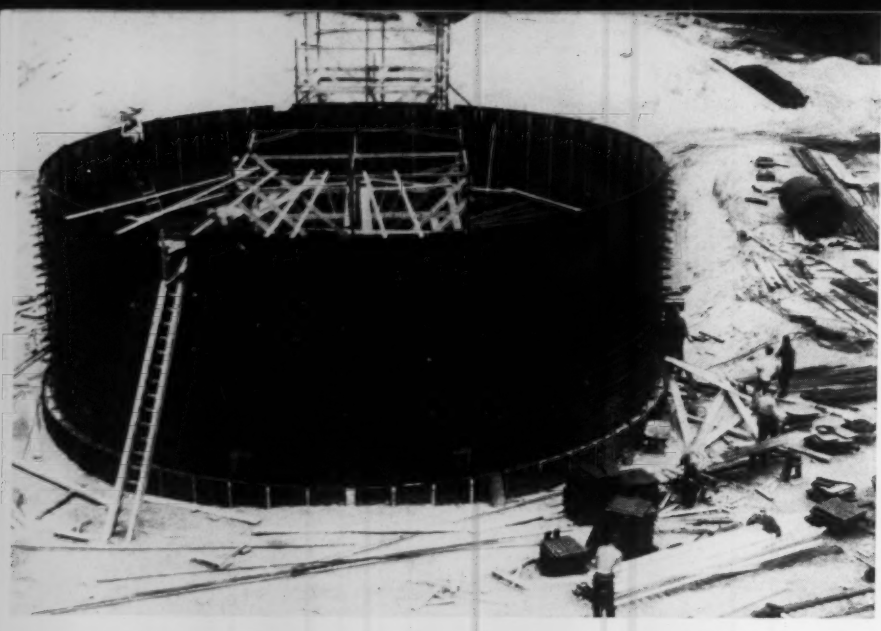


DIGESTED SLUDGE IS WASHED BY A COUNTER CURRENT IN PROCESS ELUTRIATION TANKS

Sludge is pumped from the sludge storage well to the first elutriation tank, where mixing with elutriate liquid from the second tank takes place in a mixing channel. Effluent liquids from the first tank are discharged into the sewage entering the primary settling tanks and again subjected to the sewage treatment process. Elutriated sludge from the first tank is pumped to the second, emptying first into a mixing channel where it is stirred with entering clean water. Sludge is withdrawn from the second tank by gravity to a bucket elevator, which raises it to the vacuum filters.

After liquid ferric chloride is mixed with the sludge, dewatering of the mixture is accomplished by vacuum filtration. There are two vacuum filters, of the rotary drum type. Each consists of a drum about 8 ft in diameter by 8 ft long and has an effective filtering area of about 200 sq ft. The sludge cake removed from the filter drops upon a belt conveyor, which carries it over a continuous weighing apparatus, thence to the incinerator; or, if desired, discharges it into a hopper from which the sludge may be emptied directly into trucks outside the building.

The final step in treatment of the sewage sludge is accomplished by incineration. The incinerator is a circular, multiple-hearth type, having six hearths. It is about 14 ft in outside diameter and 18 ft in height, and is arranged so that it can be fired either with sludge digestion gas or fuel oil. The ash is discharged by means of a bucket elevator and screw conveyor into an elevated



SECTIONAL METAL FORMS WERE USED FOR THE CONCRETE WALLS OF THE SLUDGE DIGESTION TANKS

ash bin outside the building, from which it is emptied by gravity into trucks and disposed of as filling.

A system of metering is provided to assist in the control of plant operations and to afford a complete operating record of the various plant units.

An auxiliary water supply for the sludge-elutriation process was obtained at the site by construction of an infiltration gallery to develop a ground-water supply. This gallery consists of two rows of 12-in. vitrified skip pipe in 2-ft lengths laid at a depth of about 10 ft. The plant water system includes the infiltration gallery and a pneumatic water system. It is estimated that the use of plant water for sludge elutriation has effected a saving of nearly $5,000 per year in the purchasing of water for operation.

The operating building is approximately 45 ft wide and 143 ft long, with reinforced concrete foundation walls and brick superstructure. It houses an office and laboratory, together with the major items of mechanical equipment that are not installed outside at the individual treatment units. This equipment includes air blowers, vacuum filters, incinerator, the plant heater, chlorinator equipment, various pumps, and an electrical control desk for operating the plant units. Control of the plant units, except those for digested sludge disposal, is centralized in the control desk. Special effort was made to obtain a compact arrangement of the plant units, and as a result practically every outside unit of the entire plant may be seen from the office, in which the control desk is located. The mechanism of the outside units may be operated at the individual units as well as from the control desk.

OPERATION OF TREATMENT WORKS

An operating force for the sewage treatment works includes eight men—namely, 1 superintendent, 1 chemist, 3 plant operators, 1 filtration and incinerator operator, and 2 laborers. The payroll of this operating force is about $16,000 per year. The estimated cost for auxiliary fuel, electricity, chemicals, tools and supplies, laboratory expenses, truck operation, and miscellaneous minor expense items is at the present time about $18 per million gallons of normal domestic sewage. Total estimated cost of treating normal domestic sewage, including the cost of the operating force as well as of the supplies and materials previously enumerated, is $23 per million gallons, when the treatment works is handling its average daily designed capacity of 5.5 million gallons per day.

On March 2, 1942, the sewage treatment works was put in operation, and by the end of 1942 there were nearly 2,100 active services and the total sewage flow amounted to some 2,400,000 gal per day. This flow consists of about 415,000 gal of infiltration (or ground-water leakage), 500,000 gal of domestic sewage, 160,000 gal of untreated wastes from the Narragansett Brewery, and 1,325,000 gal of settled wastes from the Cranston Print Works. Average operating results, when all units are properly operating, have indicated from about 92 to 97% reduction in the biochemical oxygen demand of the sewage and from 87 to 91% reduction of the suspended solids.

Vacuum filtration and incineration of the sludge have been satisfactorily accomplished. A demand has developed for the sludge cake from the vacuum filters to be used as fertilizer. At first this cake was sold at 30 cents per cu yd; but there has been so much demand for it that the price has been advanced to 50 cents, and even at this price, the accumulated surplus has been entirely exhausted.

CONSTRUCTION OF TREATMENT WORKS

Geological formation at the site of the treatment works was mostly sand and gravel, with ground-water level above the deeper excavations. Excavation was done largely by tractors hauling drag scrapers, though a limited amount was handled by bulldozer and the footings were excavated by mobile crane or by hand. The operating building, pipe galleries, aeration tanks, final settling tanks, and sludge digestion tanks were built mostly on undisturbed natural material, while the primary settling tanks, grease-removal tank, venturi-type meter chamber, grit-removal unit, and the sludge concentration and elutriation tanks were built on filled material ranging from a few feet in depth at the primary settling tanks to about 18 ft in depth at the grit-removal unit. The filling material was placed in layers and compacted by the tractors hauling drag scrapers. All filling material was placed in the late fall and allowed to settle during the winter and spring before structures were built upon it during the following summer. The total excavation amounted to about 51,000 cu yd.

Dewatering of the natural formation in which the deeper excavations were made was accomplished by a well point system, which operated continuously for a period of about two months at the beginning of the job. Metal forms were used extensively for the concrete tank structures and for the concrete of the operating building. A total of 7,500 cu yd of reinforced concrete was placed, the steel reinforcement amounting to some 480 tons. Considerable effort was made in the designs to minimize the development of cracks in the concrete by use of suitable construction joints, contraction joints, and expansion joints.

Construction started the middle of September 1940, and the bulk of the work was practically finished in about 13 months. The work was done under a lump sum contract of $658,000 and extra work amounted to approximately $7,200, making the total construction cost about $665,200.

Construction of the sewage treatment works was by James A. Munroe and Sons, of North Attleboro, Mass. Engineering designs and engineering supervision of construction were handled by Fay, Spofford and Thorndike, of Boston, Mass.

Early Movable Bridges of Chicago

Beginning with the First Floating Log Structure of 1833

By DONALD N. BECKER, M. AM. SOC. C.E.

ENGINEER OF BRIDGE DESIGN, DEPARTMENT OF PUBLIC WORKS, CITY OF CHICAGO, ILL.

THE struggle between land traffic and water traffic led to the early development of the movable bridge in Chicago. Even the city's first traffic bridge, half of which was paid for by a tribe of Indians, could be opened to permit the passage of canoes. Since then a long succession of movable bridges of various types have spanned the Chicago River. The story of the gradual development of this type of span in the Mid-Western metropolis is here told by Mr. Becker.

THE first thing that catches the eye of anyone entering the Chicago River on a steamer from Lake Michigan is the magnificent Outer Drive Bridge with its massive bascule leaves, which seem to rise by magic to permit the passage of the vessel. As the boat proceeds, bridge after bridge of this same general type open their gargantuan jaws as if to swallow it up. This is done with so little inconvenience to either the river or the street traffic that one cannot help but wonder what difficulties had to be overcome before this present efficient procedure was evolved.

First, why was it that this comparatively insignificant stream came to be chosen above all the other small streams which enter Lake Michigan for the location of the early settlement? For this Louis Joliet, a Canadian-born French explorer, and Jacques Marquette, a French Jesuit priest, were largely responsible. In 1673 they left Fort Mackinac on an explorative expedition which took them through Green Bay, down the Fox River, by portage to the Wisconsin River, and down this into the Mississippi. They returned north by way of the Illinois and DesPlaines rivers to a point where they found a short portage into the South Branch of the Chicago River. That Joliet appreciated the importance of his discovery of this return route is attested by his own words:

"The place at which we entered the lake is a harbor, very convenient for receiving vessels and sheltering them from the wind. A very great and important advantage that perhaps will hardly be believed is that we could go with facility to Florida in a bark and by very easy navigation. It would only be necessary to make a canal, by cutting through but half a league of prairie, to pass from the foot of the lake of the Illinois [Lake Michigan] to pass to the river St. Louis [Illinois] which falls into the Mississippi." These words were prophetic. Soon after, this portage came to be used by the fur traders on their way to the trading posts on the Great Lakes.

Actually the history of Chicago as a city may be said to date from 1803, when Gen. Henry Dearborn, then Secretary of War, ordered Capt. John Whistler to build a fort at the mouth of the Chicago River, appropriately named Fort Dearborn. In those days the Chicago River was a relatively shallow stream, navigable only for canoes and other small vessels. Until 1828, its entrance to Lake Michigan was blocked by a sandbar so that the channel was deflected to a point opposite Madison Street, about a half-mile south of its present entrance, as shown in an old map of Chicago dated 1830 (Fig. 3). In this year the soldiers at Fort Dearborn cut a channel through the bar. However, the first lake vessel to enter the river as far as Dearborn Street had to be literally dragged over the bar (1834). By 1837 the channel was docked and dredged so as to make it satisfactory for navigation by all lake vessels.

Soon another problem arose, the solution of which called for all the ingenuity of which Chicagoans were capable. The earlier explorers and fur traders had traveled by water, but the early settlers came by land. To them the river, although a sluggish stream not over 100 ft across, was a serious obstacle to further progress toward the West. In 1829 a toll ferry was put in operation near the present Lake Street bridge. In 1833, when this proved insufficient, a crude floating bridge of rough-hewn logs was thrown across a little south of the ferry, with the help of U.S. troops at Fort Dearborn. Engineers familiar with the cost of modern bridges may be interested in the cost of this structure of 1833. It totaled $486.20, of which the citizens contributed $286.20 and the Pottawattomie Indians, $200. This bridge could be opened for the passage of river traffic—mainly canoes. It was perhaps more picturesque than practical. Three years later it became unsafe for land traffic and was soon removed.

In 1834 the first drawbridge was built, at Dearborn Street (Fig. 1). From best information available, it

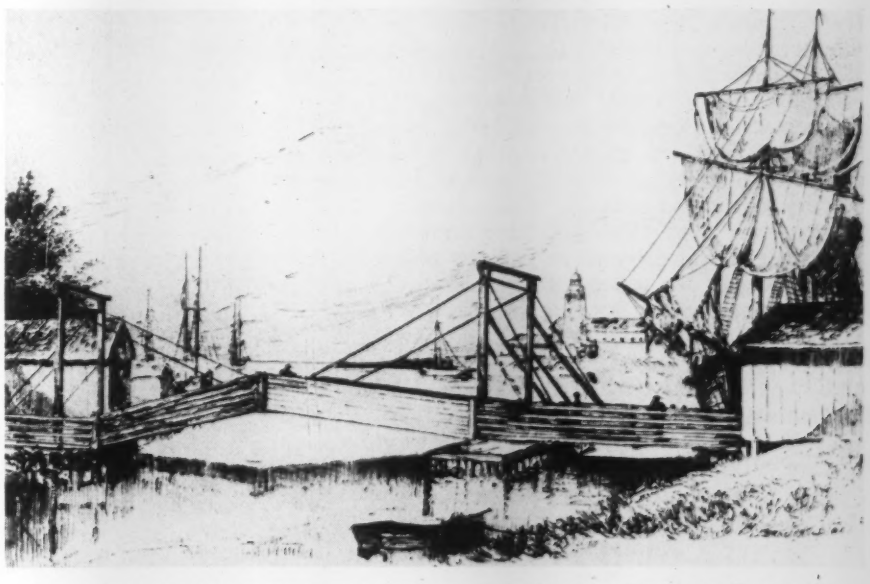


FIG. 1. THE FIRST DRAWBRIDGE SPANNED THE CHICAGO RIVER AT DEARBORN STREET IN 1834—HAND-OPERATED BY A WINDLASS

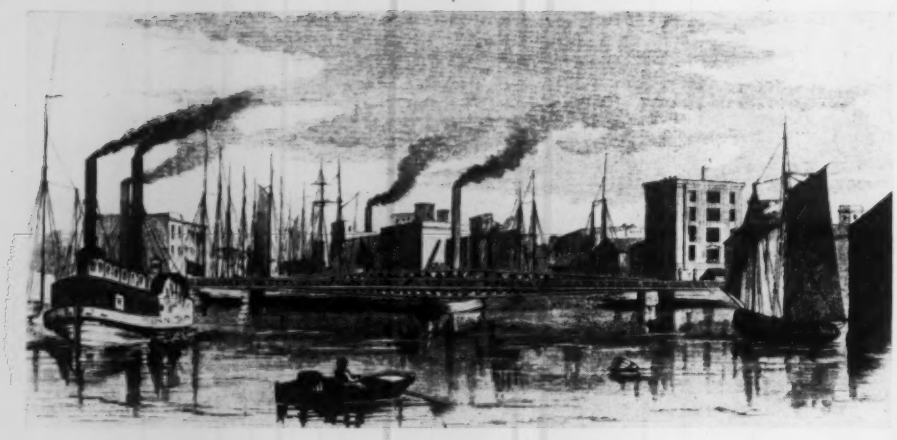


FIG. 2. CLARK STREET PIVOT BRIDGE OF 1854 HAD WOODEN TRUSSES SUPPORTED ON A PILE COUNTER-PIER

was about 300 ft long over approaches with a draw opening of 60 ft. It was made of timber, which incidentally was cut less than a quarter of a mile away. As an old description reads, it was "of the 'gallows pattern,' and for five years, the frames, one at either end, stood like instruments of death to frighten the timid stranger at night. Upon one occasion, when hoisted, it 'would not down' at anyone's bidding, and for forty-eight hours the gallows frames held the draw suspended in mid-air." So dangerous to vessels were the abutments that the Common Council ordered its removal in July 1839. Many citizens were so afraid that the Council would rescind this action, that a large crowd gathered before daylight the next morning and in a short time literally chopped the bridge to pieces.

Land traffic kept growing and soon a bridge was demanded at Clark Street. The nature of this demand was described by a writer in the Chicago Times in 1840:

"Every night there came out of the south a great fleet of prairie schooners that anchored at the Reservation. It often numbered five hundred, and came laden with wheat and corn and all sorts of produce. All the warehouses were in that day built on the North bank of the river. The South side opposed the Clark Street Bridge, in order that their prairie schooners might not reach the warehouses and thus be compelled to trade on the South bank."

Finally, in 1840 the bridge was built. It was a sort of ponton arrangement, to open which one float was pulled around by means of a chain and windlass. It was followed in 1841 by a similar one at Wells Street, two blocks west. These bridges were financed by subscriptions collected mainly from benefited people north of the river. There was still considerable objection to a bridge nearer the lake.

In 1847 a new floating bridge was completed at Wells Street at a cost of $3,200. Its total length was 202 ft, with a floating draw of boiler-iron drums, with stringers supporting the deck, which was 100 ft long from the pivot to the opening point, making a clear passageway between fenders of 81 ft. There were two tracks for teams and a sidewalk on each side for foot passengers.

In 1847, bridges were also constructed at Madison and Randolph streets across the South Branch. The latter was a semi-floating draw with a self-regulating apron; it had two tracks in the center for teams and a sidewalk on each side. It cost about $5,000. The Madison Street bridge was of similar pattern.

All these bridges were swept away by the flood of March 12, 1849, when rapidly melting snows, coupled with two or three days of heavy rain and an ice jam in the DesPlaines River (which normally drains southwest into the Illinois River), caused it to overflow into the South Branch. The head of water increased so rapidly that the ice broke up and carried with it shipping tied up at the wharves for the winter. The moving mass was irresistible; it was stopped only momentarily by each bridge in its path.

Following this catastrophe, ferries temporarily came into use again. By June 1849, the Madison Street Bridge was ready for traffic; on July 3 the Clark Street, and in September the Wells and Kinzie Street bridges. A bridge at Lake Street was completed in 1850.

From the very beginning, there was bitter strife between the river traffic on the one hand and the street traffic on the other, and also within the ranks of the street traffic itself. As early as 1847 an ordinance was passed prohibiting teams from stopping on a bridge or within 40 ft of one. There was also considerable complaint against the bridge tenders on the ground that they were very lax in the opening and closing of bridges. In general, they favored the river traffic because of the damage it could inflict if bridges were not opened promptly. In 1852 the bridgetenders were

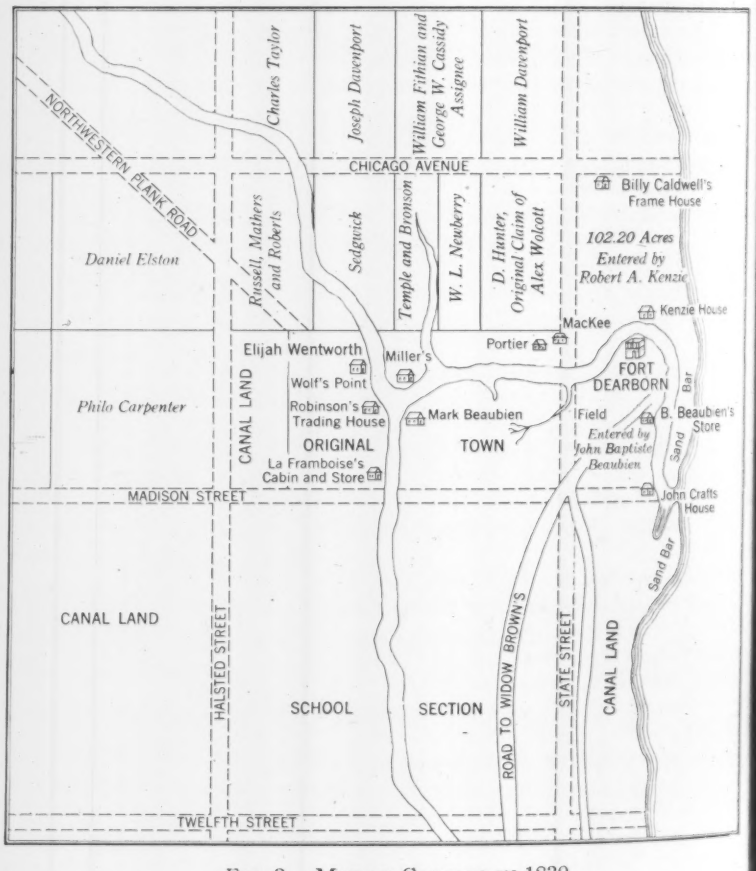


FIG. 3. MAP OF CHICAGO IN 1830

placed under a $500 bond to perform their duty, increased to $2,000 in 1854. This duty was to open and close their bridges "as quickly as possible," but so far as is known they were never punished for not doing it. By 1855 there were eight bridges in operation.

In 1854 a pivot bridge was built across the river at Clark Street at a cost of $12,000 (Fig. 2). It contained a double carriageway and sidewalks, and had wooden trusses supported upon a pile counter-pier. The following year both of the arches so-called, probably the arched top chords, gave way, but were repaired by having heavy iron plates bolted to them at a further cost of $2,145.55.

In this year a further move was made to correct the chaos in street traffic by an ordinance giving precedence to traffic running with the bridge, then to that approaching it from the right, and lastly to that from the left.

This same year an attempt was made to provide a bridge at the Fort Dearborn ferry (about Rush Street) but difficulty in financing delayed it until 1856. It was the first iron bridge in the West and cost $54,000. This showed the advance of the city since 1839 when the irate citizenry caused the removal of a bridge three blocks farther west.

Up to 1856 the bridges were built mostly at the expense of citizens whose property was most benefited. In this year a new bridge at Madison Street was agreed upon and, as it was proposed to construct it at municipal expense, a vigorous protest was entered, but this was overruled and the bridge completed the next year at a cost of $42,000. It was of iron, 155 ft long, and was the first bridge to have masonry foundations.

At the same time several other bridges were built, each larger and more substantial than its predecessor. All resisted the flood of February 9, 1857. Even in those days, Chicago evinced a desire to lead the West in the introduction of novelties which should prove of lasting value, so a swift advance was made from stringers to pile bridges, and from the original pivot to the swing bridge of 1857. Between this time and 1861, when the Board of Public Works was organized, several more bridges were built, and the Board's first report of that year shows that the city had 16. The Lake Street Bridge (Fig. 4) was typical of this period.

FIG. 5. IRON DRAWBRIDGE AT ADAMS STREET, TYPICAL OF THE PERIOD FOLLOWING THE FIRE OF 1871

In November 1863, the iron bridge at Rush Street, built in 1856, was accidentally destroyed—by the crossing of a drove of cattle. The structure dropped down on one side and fell into the river. Two of the turntable wheels had broken and the three trusses were thrown down laterally. In order to hasten reconstruction, the new trusses were made of wood, 211 ft in length, and the bridge was opened to traffic in January 1864. While the word "priorities" had not been coined then, the idea was the same as in the present war; governmental requirements for iron took precedence over other uses.

In 1865 an improved design was instituted, as attested by the following quotation from the Board's annual report for that year:

"The only important work in the way of construction in this department during the year has been the erection of a new bridge across the main river at Clark Street. The design of the bridge is by Mr. J. K. Thompson, the Superintendent for the Board in charge of Streets, Bridges, Public Buildings, etc., and it is believed to be an improvement on the other truss bridges. It differs from the trusses in use, principally in that the upper and lower chords are of iron instead of wood. The truss is like that of the other Howe truss bridges. The chords being of iron will last for a very long time, and the wooden braces can be renewed at any time, at but little cost, and with but comparatively little interruption to the travel by the bridge."

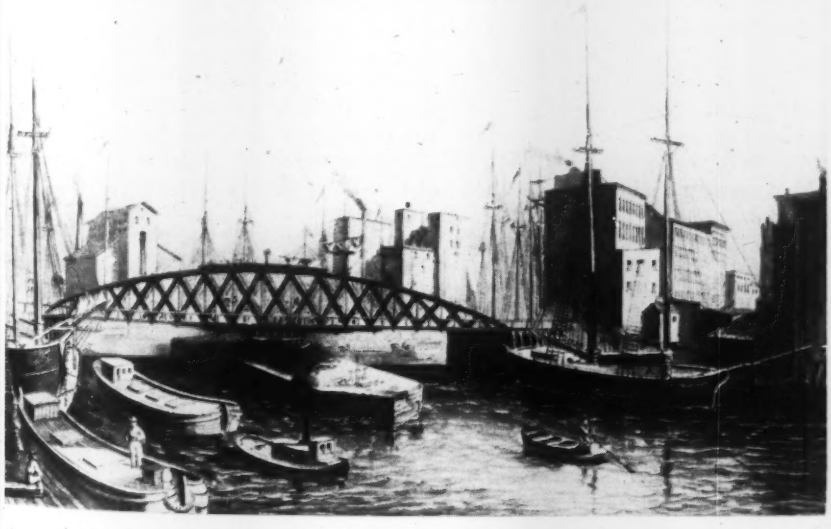


FIG. 4. LAKE STREET SWING BRIDGE, TYPICAL OF THE WOODEN STRUCTURES BUILT ON PILES JUST BEFORE THE CIVIL WAR

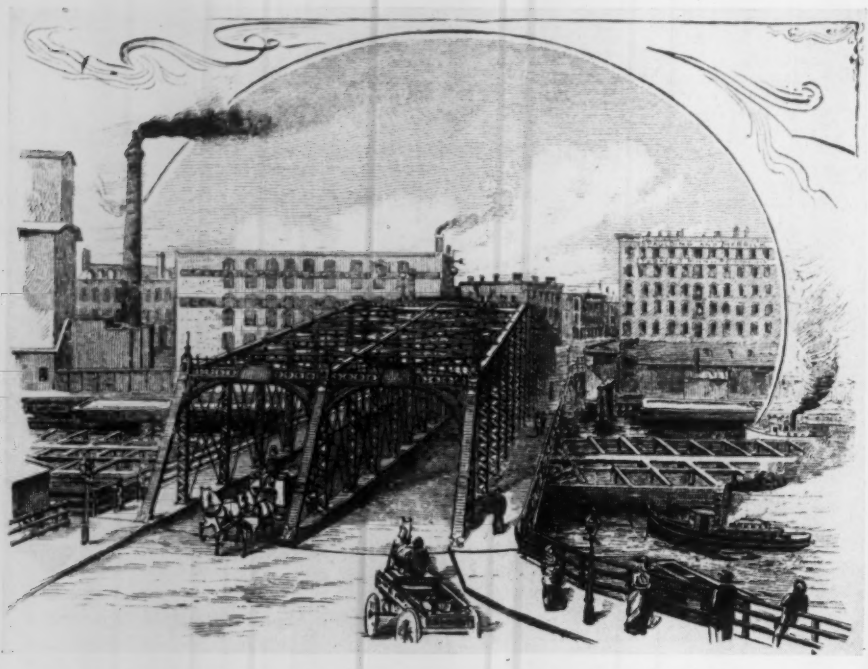


FIG. 6. A WROUGHT-IRON SWING BRIDGE COMPLETED IN 1884
This Rush Street Crossing Could Be Opened by Steam in About One Minute

A new problem was created by the open ends of the street left when the bridge turned for the passage of vessels. A great many models for self-acting gates were brought to the attention of the Board, all having more or less merit, but still likely, if put in use, to be the cause of more accidents than the unprotected street. However, the Board offered to permit several inventors of the most promising devices to install them at some important bridge with the understanding that they should be paid only if the devices proved of merit. None saw fit to stake his all on his brain child, preferring, as inventors still do, to have the experiment made at public expense.

The Board's report for 1870 showed that the city had 27 movable bridges costing well over half a million dollars. Of these, only one was all iron, 9 were all wood, and 17 were a combination. The oldest was the Madison Street Bridge, 13 years old. All but 4 were less than 7 years old, indicating that the bridges of that period were rather short lived.

By 1857 marine traffic had increased so prodigiously that the strife between it and the street traffic had developed into almost open warfare. By this time the bridges were set high enough to permit tugs and barges to pass under them, and the tugs were required to have hinged smokestacks. Thus the bridges had to be opened only for masted vessels. In 1860 red and green signals were introduced; in 1861 bells were placed on important bridges; and in 1867 an ordinance was passed requiring bridge tenders to leave their bridges open not over ten minutes at a time. This improved street conditions materially, but delayed river traffic so that it challenged the ordinance in the Courts, but was defeated. Finally, in 1869 a tunnel was placed in service at Washington Street and in 1871 one at LaSalle Street. Such tunnels were far more expensive than any bridge.

All the bridges built before 1871 were hand operated, probably by the customary T-handle through the floor of the bridge, still in use on some structures.

Chicago's great fire of October 9, 1871, destroyed eight of the bridges and several viaducts over railroad tracks at an estimated loss of over $200,000. It also isolated the center of the city from the north side, except for the tunnel under the river at LaSalle Street. By September 1872 all eight bridges had been rebuilt. A typical iron bridge of the period following the fire is shown in Fig. 5.

By 1881 river traffic had increased immensely; arrivals of vessels numbered 13,007 and departures 12,910. In July of this year an ordinance was put into effect requiring the bridges to be kept closed for one hour in the morning rush period and another in the evening.

In 1885 studies were made of the possibility of creating an outer harbor along the lake front from the river mouth to 39th Street for the accommodation of the lake boats, at which cargoes could be transferred to lighters for delivery along the river, thus permitting a change to a fixed-bridge policy. It was also proposed to cut a canal from the lake to the South Branch at about 39th Street and another at about Fullerton Avenue to the North Branch for the use of lake vessels wishing to reach the docks south and north of these respective canals. This was, beyond a doubt, the most drastic plan previously proposed to solve the problem, and if it had been put into effect, the whole history of Chicago might have been changed. However, the various interests could not get together, and the argument still continues, with proponents and opponents of fixed bridges still figuratively at one another's throats.

LATER DEVELOPMENTS

By the middle of the 80's many of the bridges were upward of 20 years old. This fact, coupled with the increase in number and weight of vehicles, made replacements necessary. Typical of the bridges built in this period is that at Rush Street (Fig. 6) completed in 1884, which was of wrought iron, 240 ft long by 50 ft wide, providing two 18-ft roadways and two sidewalks 8 ft wide in the clear. It had three trusses resting on a turntable of the "rimbearing" type, the load being carried on 74 cone-shaped cast-iron rollers. The bridge was operated by steam-driven machinery and could open for river traffic in about one minute. It was equipped with electric lights from a dynamo with its own steam engine. Its cost was $128,000. The total weight of the superstructure was 657 tons as compared with 130 to 160 tons for some of the older bridges. This bridge lasted until 1920, when it was replaced by the Michigan Avenue Bridge.

By 1890 the number of bridges had risen to 48, ten of which were added in annexed territory. The annual maintenance was about $100,000 a year.

The decade of the 90's represents another stage in the development of Chicago bridges. It was during this period that a start was made in getting away from swing bridges and in providing clear channels for navigation. These developments are beyond the province of this paper but are covered in that by the writer entitled "Development of the Chicago-Type Bascule Bridge" in the February 1943 issue of PROCEEDINGS.

Thanks are given to the Chicago Historical Society for permission to use Figs. 2 and 4.

Peat Salvage and Reclamation of Bog Area

Explosives Displace Swamp Materials

By OSCAR F. BURBANK, ASSOC. M. AM. SOC. C.E.
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BECAUSE of the growth of Hope Cemetery, at Worcester, Mass., about 55 acres of land had to be added to the 90 acres already laid out. The area to be added included a bog of 20 acres together with a number of knolls and hillocks composed of sand and gravel with deposits of clay, boulders, and shale. The bog, a depression where vegetable matter had accumulated to form a considerable peat deposit, was periodically submerged because of obstruction to natural drainage. It was tapped in two places by a 12-in. drain emptying into a 20-in. sewer. However, this drain was largely ineffective because, while laid to minimum grade, the inlet was still far above the level of the bottom of the bog. Furthermore, open trenches could not be maintained in the material, which was both peat and mud. The problem therefore was to reclaim the area by removing the peat and replacing it with soil and turf.

The term "peat" is a very broad one, covering a great variety of deposits. Ordinarily the black peat is old and much disintegrated, whereas the brown is of later origin. Some types absorb and hold moisture, improve the soil texture, and provide a congenial medium for the growth of bacteria and other micro-organisms that prepare plant food for crop consumption. These types supply raw material for the manufacture of humus.

Crude peat of course is not humus. But humus is the product resulting from decomposition of organic matter such as is contained in peat. Peat is colloidal and certain types contain 90% water by weight. Thus, when incorporated with other soil, it greatly increases the power of the mixture to retain water. When such soil is of low-grade, sandy structure, peat will give it body and substance. Conversely, it will create a granular texture in heavy soil, admitting air and encouraging expansion of the plant root system. However, peat is not a fertilizer, nor is crude, unmixed peat a supporter of plant growth. On the contrary, it arrests growth and for this reason is often used as a mulch for shrubs and perennials and to keep down weeds. But eventually it decays and becomes an important soil element.

The cross section of the area to be reclaimed showed approximately 70,000 cu yd of peat, more than enough for use in grading the undeveloped area. The fill required was estimated as 400,000 cu yd, about 180,000 more than was available on the property. However, the extra fill was obtainable within a reasonable hauling distance.

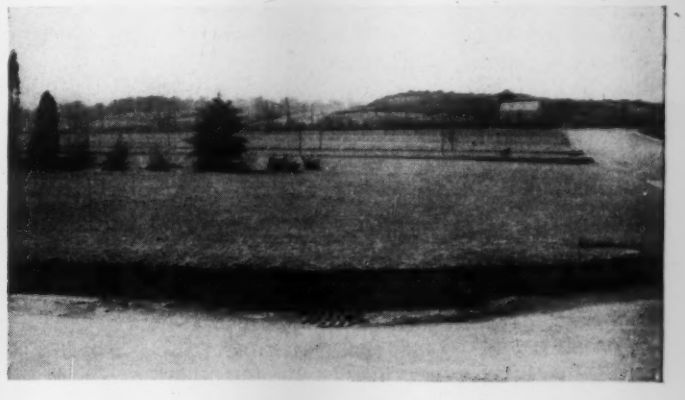
A typical section of bog comprised a top layer of light brown peat into which roots of underbrush and small birches penetrated 12 to 18 in. Under this, the permanently submerged peat became progressively darker in color with depth. Under the peat was a thin layer of silt-mud, and the bog bottom was hard gray sand. From the shore line the depth of peat dropped sharply to 5 ft. The maximum depth was 35 ft, and the average 20 ft. The water level varied with rainfall and season.

Over a period of thirty years, peat had been collected from the area by haphazard and primitive methods. The year's supply was harvested during the winter. The water level was usually low at that season and the frozen surface of the bog would support horses and tip carts. Working small sections, it was possible to recover many loads of peat before water seeped in sufficiently to interfere with operations. The peat was dumped on sloping ground, drained, weathered, and used the following spring or as needed.

More recently, a bottomless scraper bucket on a 300-ft cableway, powered by a double-drum hoist mounted on a tractor, was tried. The tractor was anchored well back from the shore line and the peat piled or loaded. This worked well enough for the dry top layer, but as the bucket was drawn back through the wet peat, the churning action soon reduced it to a gummy paste. Miring of the bucket became frequent, followed by cable breakage. Considerable peat was removed by this means, but it was apparent that it was not adapted to large clearing operations.

Still later, runways were graded from the shore to bog level, to serve as ramps from which to operate shovels with dipper and clamshell buckets. This method also proved unsatisfactory, as more time was consumed in maintaining the ramps than in excavating the peat.

Some years before, a stretch through the bog had been made passable by dumping fill on top of the peat, and as it settled, adding more fill in order to keep the traveled way above water. Some variation of this displacement method was indicated, and the use of explosives to re-



BEFORE AND AFTER RECLAMATION OF BOG AREA

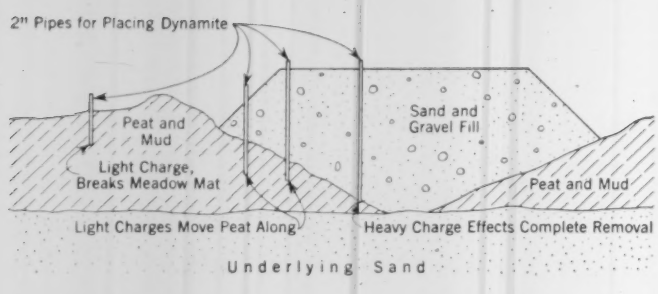

2" Pipes for Placing Dynamite
Peat and Mud
Light Charge, Breaks Meadow Mat
Sand and Gravel Fill
Peat and Mud
Light Charges Move Peat Along
Heavy Charge Effects Complete Removal
Underlying Sand

FIG. 1. SECTION THROUGH EMBANKMENT SHOWING DISPLACEMENT METHOD

move the bog material was decided upon. The brush was cleared, the meadow-mat blasted with light charges along a strip 20 ft wide, and a dike was built into the bog. The upper layer of peat at this time was dry, the water level being a foot or two below the surface. The breaking up of this meadow-mat was incidental to stirring up or churning the peat to accelerate fill settlement by displacement. The semi-fluid, gummy consistency of the peat which had interfered with or checked previous operations, was an advantage at this stage. It was now helpful in building the heavy fill material into a solid roadway capable of supporting the weight of excavating machinery and trucks.

BLASTING MEADOW-MAT AND UNDERFILL

In blasting the meadow-mat, single sticks of dynamite were thrust into the bog 4 ft deep and about 18 in. apart. Stretches of 300 ft were fired by propagation. One stick only was capped and the concussion in the water-soaked peat detonated the rest. Trucks fed by shovels in nearby pits carried the fill as close as safety permitted and dumped it on the torn mat. It was then spread by bulldozers, rapidly extending the dike. Broken ledge, large boulders, and rock were used in the base of the dike, and on them clay, gravel, and rough fill were placed. For about a hundred feet the trucks dumped by backing, and bulldozers completed the placing. Six to eight trucks of 2 to $2^1/_2$-cu yd capacity dumped fill in turn. About 300 ft from the starting point a short dike was extended 300 ft easterly to the shore line to provide a bypass for the equipment, and to prevent interference with further blasting operations. Side trenches were cleared of peat down to water level.

After the dike had been partially compacted by traffic, preparations were begun to blast the under fill. A line of 2-in. pipes (Fig. 1), 10 ft apart, was driven in the center of the dike to a point below the bottom of the fill and into the center of the peat pocket. The pipe-driving rig consisted of a 10-ft A-frame on skids under a deck carrying the 2-hp air-cooled gas engine. This power raised a 60-lb cylindrical weight by friction of the rope around a drum. The weight, fitting loosely around the pipe and driving against a coupling, was operated by one man. By delivering an upward blow, it could also be used to withdraw the pipes. Usually, however, the explosion freed the pipes so that they could be withdrawn by hand and used more than once. This hammer rig was used also for taking test samples with a "spoon bit" screwed to a $^1/_2$-in. pipe. The rig was light, easily shifted, and safe for use on narrow ledges.

When the top layer of fill had been penetrated, driving was not difficult, and below the peat line it was quite easy. When stones were encountered, the pipes slid off to one side or were withdrawn and slanted. The dynamite crew loaded each chamber, wired the charge, then withdrew the pipe, and plugged the hole with sand. Holes 20 ft deep or more required 15 lb of dynamite. Lesser depths received lighter charges to avoid blowing away the fill.

Two other lines of pipes were driven through the shoulders of the dike 10 ft outside the center line. These lined up with a point halfway between the center pipes. Each was loaded with a charge of 8 to 10 lb. The dike was fired in 100-ft sections, and there was no scattering of fill. The dike mass was lifted about 3 ft and the peat below forced into the relief trenches at the sides, which it filled. The average settlement was 5 or 6 ft. As successive sections were blasted and regraded, the dike became a smooth stable runway from which to operate machinery not only for the recovery of peat but for extending and widening the dike itself. Many test borings were made during the progress of the work before and after the under-fill blast.

Peat and mud were seldom found under the dike after firing. As the layer of mud was insignificant and usually removed with the peat, it was easier to separate the two after excavation and draining. During operations, when a considerable volume might collect in low spots, the mud was shoveled out, dumped on top of the fill, left to dry, and buried.

The effect of the under-fill blast on the peat was to force it from under the dike so violently that it not only filled the relief trenches but actually raised the level of the adjoining bog 5 or 6 ft. This allowed the peat to partially drain and placed it in position for the shovel to reach it more easily. The relief trenches were of slight use for drainage as the material would flow with the water, and when left for a short time, level itself off. It was found that the only effective method of draining the peat was to dump it on sloping ground and leave it to drain itself.

When a section of bog had been divided by dikes into separate compartments or pools, fill was dumped in from all sides and the peat removed as it rose. The fill would settle to the bottom and float the peat upward. The section could thus be cleared, and if a little remained, it was left to dry out and then spread. Where the peat was 6 ft or less in depth and fairly dry, ramps were built down to it and dipper buckets used for removal. This was a much more rapid method than the clamshell buckets, but accumulations from summer showers usually put an end to the procedure.

After draining for about a year, the excavated peat was spread on the new fill by bulldozers to a depth of 12 in. Tractor-drawn harrows worked it over and any roots and limbs left in it were removed. Agricultural lime was spread in such amount as was required to produce a soil reaction only slightly acid (about pH 6.8). Loam of any grade available was spread, mixed with the peat, and harrowed. The section was then rolled and brought to a rough grade. Commercial fertilizer (or manure, when obtainable) was spread and topped with a one-inch course of screened loam. Seeding was by spreader carts; the seed was raked in; and a final light rolling was given. This sequence of operations produces very satisfactory results. The effects of even a severe drought are only temporary and a shower or two restores vigor to the turf. The project was carried on mainly with machinery, and hand labor was used only in straightening out the finished grades, seeding, and similar tasks. A large portion of the undeveloped area is now in use or ready for use. The remainder is rough graded and can be completed when required at comparatively small expense. The bog is entirely filled, all the knolls have been leveled, and the peat has been stored so that it is available whenever needed to grade new sections.

The Design of Shasta Dam

Part III. Spillway Control by Drum Gates

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FOR regulation of spillway overflow at Shasta Dam, three floating drum gates are provided. Although similar gates have been used on ten other dams designed by the U.S. Bureau of Reclamation, in only one case has the 110-ft span of these Shasta gates been exceeded. This third, and last, paper in Mr. Keener's interesting series on Shasta Dam appears as the concreting of the mighty project nears completion.

AS stated heretofore (see Parts I and II in the June and July issues of CIVIL ENGINEERING) the upper 500,000 acre-ft of storage in Shasta Reservoir, which represents a depth of 17 ft, is to be reserved primarily for flood control. Beginning around the end of March of each year, it is planned to encroach upon the space reserved for flood control and to have this space filled by the end of the spring flood season. The storage will be drawn upon by downstream requirements to the extent that the flood control space at least will be vacated and thus available for use during the rainy season, which begins about November of each year.

Consequently, it was required that flow over the spillway be regulated to retain as much storage as possible in the reservoir when the runoff is low, and also to permit large overflows during the flood season without an objectionable rise or fall in the reservoir water surface. The retained storage would be valuable for irrigation and other downstream requirements, including development of power, and the increased average head gained thereby would result in the generation of additional power at the Shasta Power Plant.

In choosing the type of control for the reservoir flow over the spillway at Shasta Dam, consideration was given to economy both in initial cost and in operation and to adaptability to the hydraulic and physical requirements. The physical and economic requirements called for a total length of control gates not greatly in excess of the 300-ft width of the river channel into which the spillway would directly discharge. Another physical condition to be met was the probability that debris and trees would be carried over the spillway during flood periods, despite the clearing of the reservoir area and other precautions. Thus, a type of gate was required which would have sufficient depth to carry the maximum overflow without greatly exceeding the width of the river channel, and sufficient length so that the spacing between intermediate piers would be adequate to insure against the possibility of debris or log jams. Also, in order to control the power head closely and without waste, it was desirable to have a gate that could be automatically operated.

The ordinary slide gate and the Stoney gate were ruled out on account of high cost, narrowness in width, and the impracticability of automatic control. Although these gates could be made to operate automatically, the large amount of friction would make such control sluggish and expensive. The use of radial gates was not feasible because of the unusual length and depth of gate required. The largest gate of this type thus far installed by the Bureau of Reclamation is at Caballo Dam, in New Mexico, where the length is 50 ft and the height 21 ft. Radial gates of the large size required at the Shasta installation would impose too greatly concentrated loads on the piers.

The floating type of drum gate was selected to regulate the spillway discharge over Shasta Dam, because it closely satisfied the various requirements. Comparatively reasonable in first cost and inexpensive in operation, it will give rapid and close control without obstructing the passage of flood debris. This type of gate has been used successfully on concrete-overflow crests in many installations designed by the Bureau of Reclamation. However, a number of improvements have been made since the earlier designs.

THREE 110-FT GATES PROVIDED

Plans for Shasta Dam provide for the installation of three of these gates, each 110 ft long, with an effective operating height of 28 ft on the straight overflow section of the dam between the curved abutment sections. The three gates are to be separated by two concrete piers 15

ENTIRE FLOW OF SACRAMENTO RIVER IS PASSED THROUGH DAM AS CONSTRUCTION OF SHASTA PROCEEDS

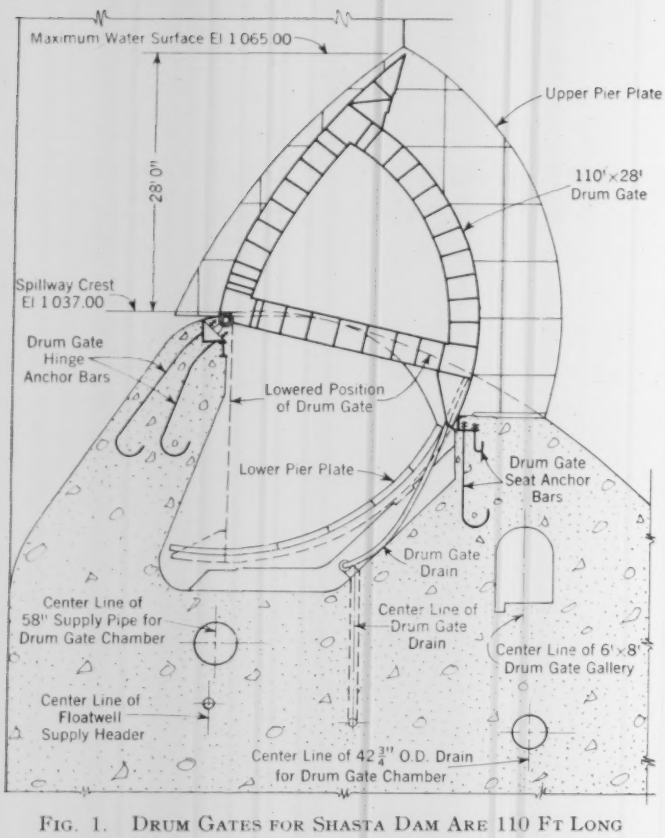


FIG. 1. DRUM GATES FOR SHASTA DAM ARE 110 FT LONG

ft wide, each of which will contain the operating mechanism for the gate located on its right. The operating machinery for the left gate will be located in the left abutment section. The piers will also serve as supports for a steel-girder bridge carrying the 30-ft roadway on top of the dam. In the top of the concrete crest of the spillway section, chambers or recesses, of appropriate size to receive the gates, will be formed so that when the drums are in the lowest position their top surfaces will complete the shape of the ogee crest of the spillway. A typical cross section of the spillway crest, with a gate in its raised (or closed) position, is shown in Fig. 1. The dashed lines indicate its lowered, or fully open, position.

Each gate will be an assemblage of 31 plate-girder frames, triangular shaped except for curvature in the upstream and downstream legs. These frames will be fabricated into one structure by skin-plate covering and plate-steel bulkheads in the end frames, and the whole will be thoroughly calked to make it watertight. Thus capable of being floated, this 830,000-lb structure will be hinged at each girder-frame location to the upstream edge of the hydraulic chamber, so that it may be rotated to any position within the limits of the 28-ft operating height. The reservoir face of the gate will be extended by a structural-steel, triangular-shaped lip, which will be part of the effective height of the gate in its raised position. This lip will seat on the downstream edge of the hydraulic chamber in the fully lowered position of the gate. Likewise, the downstream sharply curved face will be extended by a lip, which will permit greater upward rotation of the gate. At the end of this lip a rubber-covered, structural-steel stop will prevent further upswing of the gate.

As the completed drum will be an unusually rigid structure, no dependence can be placed on deflections to obtain an even distribution of load on the hinges. For this reason, provision is made for adjustment of each hinge anchor to obtain bearing contact with the hinge pin, after the drum has been completely fabricated in final position. Also, to prevent non-uniform deflection of the upstream concrete cantilever in which the hinge anchors are embedded, which would result in uneven bearing on the hinges, contraction joints are provided to avoid restraint between the ends of the cantilever and the adjacent concrete, Fig. 2. The maximum downstream deflection of the cantilever when the gate is in the fully raised position may approach $^1/_8$ in.

The designs provide for water stops, or seals, for all movable contacts between the drum and the hydraulic chamber, as well as the adjacent pier faces. In order to have a smooth bearing surface on the piers, cast-iron plates are embedded in the sides of the piers (see Fig. 1). All seals are to be made of spring brass, the end seals being attached to the rim of the drum and bearing on the finished surfaces of the pier plates. The downstream seal is fastened to the gate seat casting and contacts the downstream skin plate of the drum. The hinge seal is composed of two parts—a cylindrically formed plate attached to the gate hinge, and a flat plate fastened to the hinge anchor base, the latter bearing on the former at its free end. Water pressure will keep all seals in contact with the bearing surfaces. With the exception of those at the hinge, the pressure sides of the seals will be covered with $^3/_{16}$ in. of rubber.

DRAINS PROVIDED FOR GATES

Although the drum will be thoroughly calked, it is probable that some leakage will find its way into the interior. To provide for this eventuality, 4-in. armored rubber drain hoses are to be fitted to each downstream corner with ball-and-socket joints. The outlet end of each hose will lead downward, to a connection in the bottom of the hydraulic chamber, with a 6-in. drain (Fig. 1). The drain, in turn, will connect with the large drain from the drum-gate chamber. After the interior and exterior surfaces of the drum are painted it will be ready to serve as a bouyant vessel hinged throughout its length and limited in its rotational movement to the prescribed vertical height, in this case 28 ft.

The desired position of each gate will be controlled by valve regulation of the inflow of water direct from the reservoir into the hydraulic chamber and the outflow therefrom into drainage conduits formed in the dam. Close regulation of these operations will be possible by both automatic and hand controls within the operating chamber, or by remote control from the power house. It is expected that the normal sequence of operations will be by automatic float-well control. In the latter operation, as the rising water surface in the reservoir approaches the fixed concrete crest of the spillway, the floating drums, or gates, will rotate upward, keeping the highest level of the gates above the reservoir water surface—a process caused by the rising of the water in the hydraulic chamber as water rises in the reservoir (Fig. 2).

When the gates have been floated to their highest position and overtopped by the rising reservoir, they will lower automatically, thus permitting overflow in an amount sufficient to maintain the reservoir water surface at its full level. With a receding reservoir, the reverse of that operation will take place—the gates return first to the fully raised position, after which they lower progressively as the reservoir water surface lowers. By that sequence of automatic operations the active storage capacity of the reservoir may be kept at a maximum, and a greater average operating head will be available for the generation of power. As previously explained, the latter is a requirement.

Although the control facilities for each gate are independent of those for the others, they are identical in design. In normal operation the gates will be controlled at the same elevation to distribute uniformly the flow into the river channel. As this may be readily accomplished with the close controls available, there would be little object in supplying additional machinery for synchronous operation. Accordingly, no provision is being made for such a feature at Shasta Dam, nor has it been made on any of the Bureau's previous installations.

CONTROL EQUIPMENT

Inflow of water from the reservoir into the hydraulic chamber is through a formed transition and a 58-in. supply pipe, the first leg of which is located normal to the axis of the dam and directly under the center line of the control chamber. The length of this leg is just sufficient for the installation of a 57-in. butterfly regulating valve and an elbow to the right, from which it continues horizontally on a short tangent parallel to the axis to a point a little beyond the left wall of the chamber, where it elbows vertically upward to its outlet within the drum-gate chamber. Debris is screened out by a trash rack at the rectangular inlet end of the transition. Operation of the butterfly valve is by a motor-driven, geared mechanism installed on a platform in the control chamber.

Outflow from the drum-gate chamber is through a 24-in. pipe drain, the discharge being regulated, as the drain passes to the left and vertically downward through the lower part of the control chamber within the pier, by a 24-in., internal, differential needle valve. An emergency, hand-operated, wedge-gate valve is placed in the line immediately ahead of the needle valve, in the event that repairs are required on the latter. Below the floor of the control chamber the drain turns, running horizontally and directly downstream to a connection with a $42^{3}/_{4}$-in. longitudinal drain, which carries the discharge to an outlet on the downstream face of the dam. An auxiliary 24-in. drain is provided with discharge into the $42^{3}/_{4}$-in. drain, the flow being controlled by another hand-operated, wedge-gate valve.

Another major feature of the gate control is the float well vertical shaft, 5 ft in diameter, formed in the concrete above the control chamber. When the gate is in automatic operation, the water surface in the well is maintained at reservoir elevation by means of a supply pipe leading from the upstream face of the dam. Drainage from the float well is into the drum-gate chamber drain. The movement of the float, with fluctuating reservoir water surface, plays an important part in regulating the outflow from the hydraulic chamber through the 24-in. needle valve, as will be explained later.

A metal shaft extends from the left end of the drum-gate hinge pin, through the concrete, and into the control chamber. At the end of this shaft, which rotates with the gate, there is attached a $15^{1}/_{2}$-in. segmental operating sheave. To the latter is fastened a $^{3}/_{8}$-in. wire rope, or control cable, of high-tensile bronze that runs down and under a sheave, fixed in automatic operation, and then up and over a floating sheave suspended by connection with the float.

The control cable then runs downward, with an intervening turnbuckle and weight on its line, to a connection with the central tube, or pilot valve, of the 24-in. regulating needle valve. The weight, or slack-rope take-up, serves to prevent the tube in the needle valve from sticking. When the tube is raised, the annular opening between the needle-shaped piston and its seat is enlarged by corresponding upward movement of the needle, thus increasing the discharge of water from the gate chamber, with consequent reduction of upward pressure on the drum. Thus the gate lowers under its own weight and that of the water flowing over its crest, and the overflow from the reservoir is increased. Conversely, when the tube is lowered, the area of the valve opening is decreased, thus diminishing the flow from the gate chamber and increasing the pressure on the drum, causing it to rise and reduce the reservoir overflow.

A cross section through the 24-in. internal, differential regulating valve is shown (Fig. 3) in its fully open position. The movement of the plunger, or needle, and consequently the opening of the tube valve, is controlled by the central pilot tube. The lower open end of the tube extends down to a seat immediately above the tip of the plunger. When water is admitted from the drum chamber into the valve in its closed position, it enters into the upper chamber *A* and slowly finds its way through a predetermined fixed clearance *B*, between the circumference of the diaphragm and the base of the needle into chamber *C*, where it builds up a unit pressure approximately equal to that in chamber *A*.

Since the effective area of chamber *C* is considerably greater than that of chamber *A*, the pressure in the former acting upon the interior of the conical nose of the needle forces it downward against its seat. When the pilot tube is raised, water escapes from chamber *C* upward

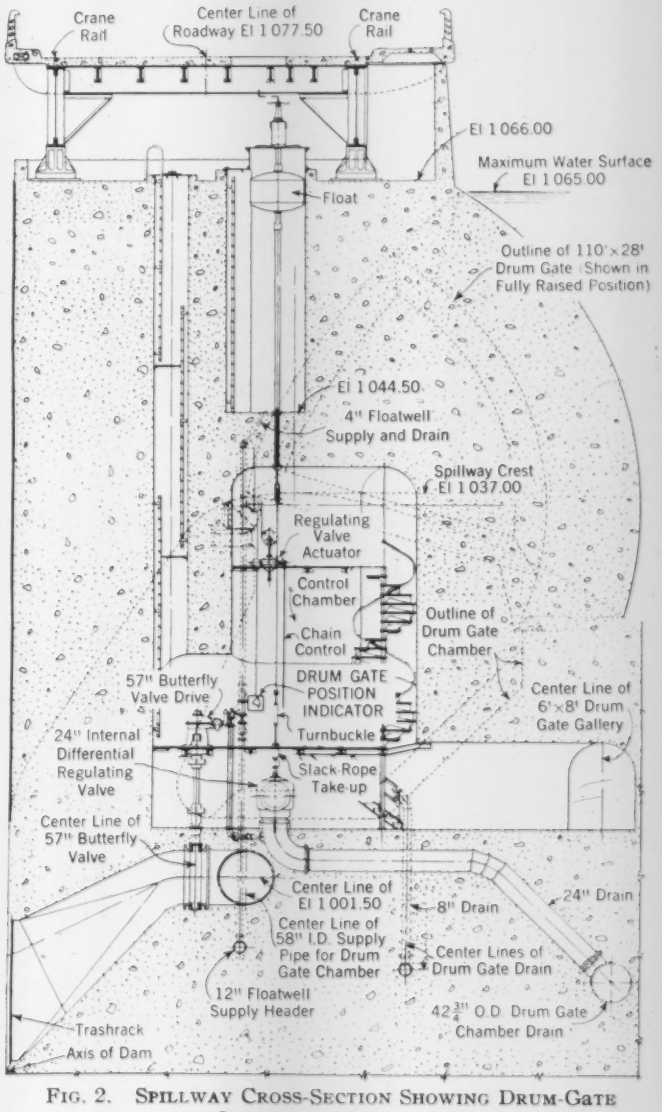

Crane Rail
Center Line of Roadway El 1 077.50
Crane Rail
El 1 066.00
Maximum Water Surface El 1 065.00
Float
Outline of 110'×28' Drum Gate (Shown in Fully Raised Position)
El 1 044.50
4" Floatwell Supply and Drain
Spillway Crest El 1 037.00
Regulating Valve Actuator
Control Chamber
Chain Control
Outline of Drum Gate Chamber
57" Butterfly Valve Drive
DRUM GATE POSITION INDICATOR
Turnbuckle
Center Line of 6'×8' Drum Gate Gallery
24" Internal Differential Regulating Valve
Slack-Rope Take-up
Center Line of 57" Butterfly Valve
Center Line of El 1 001.50
8" Drain
24" Drain
Center Line of 58" I.D. Supply Pipe for Drum Gate Chamber
Center Lines of Drum Gate Drain
12" Floatwell Supply Header
42 3/4" O.D. Drum Gate Chamber Drain
Trashrack
Axis of Dam

FIG. 2. SPILLWAY CROSS-SECTION SHOWING DRUM-GATE OPERATING MECHANISM

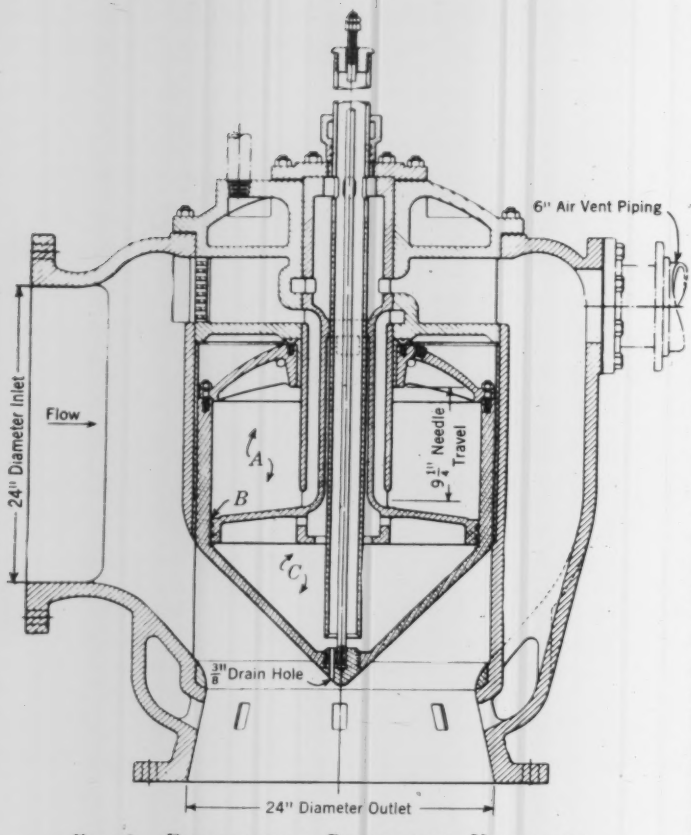


FIG. 3. DIFFERENTIAL REGULATING VALVE FOR DRUM GATE CONTROL

through that tube and discharges, through ports in the upper end of the tube, into a passageway between the outer wall of the valve and the outside of the cylinder, from which it passes into the 24-in. drain. When water is released from chamber *C*, pressure therein is relieved to such an extent that the pressure still remaining in chamber *A*, acting upward upon the top domed surface of the plunger, raises the needle from its seat with resultant discharge into the 24-in. drain.

The coordination of the control equipment may be shown by description of a cycle of automatic operation, together with the initial adjustment. For that purpose it will be assumed that the gate has been raised to its highest, or fully closed, position, with a full reservoir water surface. That position of the gate has been effected by admitting water through a slight opening of the butterfly valve and the 58-in. pipe into the hydraulic chamber. The opening in the butterfly valve may be permanently set later so that the discharge, as determined by trial, will be sufficient only to compensate for leakage with the control valves closed.

Proceeding with the operation, the 24-in. emergency wedge valve is opened and the needle valve is closed. The central tube in the needle valve is raised by adjustment of the turnbuckle just sufficient for a discharge through the valve which, plus any leakage from the drum-gate seals, will equal the flow through the butterfly valve into the drum chamber. Thus, a balancing pressure is established, and this maintains the drum gate in the fixed position during the time when there is no change in the inflow into the reservoir and, consequently, in the reservoir water surface.

When the inflow increases, with an attendant rise in the water surface in the reservoir and in the float well, the float will rise, thus lifting the floating sheave and the pilot tube in the needle valve. The latter operation increases the discharge through the valve, and by a consequent decrease of pressure beneath the gate causes it to drop slowly. The descent of the gate rotates the segmental sheave, directly connected to the gate pin, causing a slackening in the cable which permits the weight in the line to force the needle-valve pilot tube downward. The downward movement decreases the discharge from the gate chamber, through the valve, and further descent of the gate is stopped. When the reservoir inflow decreases, the reverse of the operations takes place.

REMOTE CONTROL PROVIDED

Provision is made for hand control by a hoist installed on top of the float-well decking, by means of which the floating sheave is raised or allowed to drop, thus regulating the discharge through the needle valve. Remote control is accomplished by an electric-motor-operated actuator, or geared drive, located on a platform in the upper part of the control chamber. This drive regulates the vertical position of the lower sheave, fixed in automatic operation, around which the control cable passes. Movement of this sheave, affecting the position of the pilot tube, regulates the discharge through the needle valve, as previously explained. The position of the sheave may also be regulated by a chain kept within reach from the lower platform in the control chamber, which provides an additional method of hand control. It will be noted in Fig. 2 that the position of the drum gate is indicated by a dial within the control chamber—the pointer, which is a small replica of a cross section of the gate, being connected with the extension of the gate hinge pin. The position of all three gates will be indicated in the power house by a five-wire transmitter and receiver.

In preparing this series of articles, an effort has been made to emphasize the factors that influenced the decision to build a dam at the particular site selected, as well as those influencing the design of the dam itself. However, it must be kept in mind that a comparatively long period of time is required to build a structure the size of Shasta Dam, and that in the meantime conditions change and there are developments in engineering practice. Thus, if full advantage of these developments is to be taken, the design for any complex structure such as Shasta Dam cannot be considered final until construction has been completed.

Since 1873 various federal agencies and the state of California have been investigating the water resources of the Sacramento and San Joaquin rivers, which comprise what is now known as the Central Valley Project. Comprehensive investigations resulted in the formulation of the "State Water Plan" that was reported to the legislature of the state in 1931 by B. B. Meek, Director of Public Works, and Edward Hyatt, State Engineer.

In 1935, upon the recommendation of Secretary of the Interior Harold L. Ickes, an allotment of $15,000,000 was made by President Roosevelt, for further investigations, preparation of designs, and the beginning of construction of the project. This work was assigned to the Bureau of Reclamation which at that time was headed, in Washington, D.C., by Commissioner Elwood Mead. John C. Page was Commissioner from January 1937 until his resignation in June 1943. Since that date Assistant Commissioner H. W. Bashore was Acting Commissioner until his appointment as Commissioner on August 2, 1943. In the Denver office of the Bureau, S. O. Harper is Chief Engineer; W. R. Young, formerly Supervising Engineer of the Central Valley Project, is Assistant Chief Engineer; and J. L. Savage is Chief Designing Engineer.

Steel Landing Mats for Airplane Runways

By G. G. GREULICH, ASSOC. M. AM. SOC. C.E.

CONSULTING ENGINEER, SPECIALTY DIVISION, GENERAL SALES DEPARTMENT, CARNEGIE-ILLINOIS STEEL CORPORATION, PITTSBURGH, PA.

EMERGENCY airfields in out-of-the-way places demand portable landing mats. The story of the development and use of these mats is an epic of American ingenuity and industry. One type of steel mat—and a most successful one—is covered here. The objectives set by the military authorities were many and difficult, but the perforated and ribbed construction that was developed filled every requirement. Mr. Greulich's paper was originally presented before the Pittsburgh Section of the Society.

REPORTS from military observers in Europe during 1939 indicated the necessity for some form of readily transportable surface covering, or decking, for airplane landing fields, which could be quickly installed even when in contact with the enemy. The War Department conferred with manufacturers and invited suggestions. Specific objectives were:

1. To provide portable landing mats, permitting continuous operation by pursuit, medium and heavy bombardment, reconnaissance, and transport planes.
2. Mats sufficiently rigid to give reasonable load distribution and bridge small irregularities in the ground surface, yet flexible enough to conform to the general contour of the runway.
3. Strength, continuity, and flexibility in the joints so as to distribute loads to adjoining pieces.
4. The possibility of being laid at high speed, day or night, which necessitated adequate tolerances in connections between pieces while retaining high strength and simplicity of detail in the interlock.
5. Convenience for hasty repairs even under enemy attack—the interlocking must permit individual removal or replacement at will.
6. No rough projections or corners to damage tires.
7. Availability in huge quantities—that is, for mass production.
8. A surface pattern to facilitate camouflage—this was stressed as of prime importance.
9. Weight less than 7 lb per sq ft and compact stacking or nesting to conserve vital cargo space.
10. Sufficient irregularity of surface to provide skid-proofness for large plane tires, but with openings so small that ordinary vehicular and foot traffic, particularly the latter, would not be impeded.
11. Sufficient thickness of component members to insure reasonable life under corrosive tropical conditions and to prevent local kinking or damage; yet sufficient thinness to permit straightening or reconditioning in the field.

ENGLAND'S EXPERIENCE HELPED

It was indicated that the portable landing mats might be divided into two general classes: (1) Light weight—for pursuit and observation planes, and (2) heavy weight—for bombardment ships.

As background for our own study a careful analysis disclosed the English and French methods. The English were fortunate in having many suitable sites for runways, as their park-like estates had level areas where the turf had been built up and solidified by years of sheep and other grazing. Light planes were able to make many landings without damaging this turf even in wet weather. However, as the number of flights and sizes of planes increases, it was found desirable to employ some means of protecting and stabilizing the surface to prevent rutting.

These conditions led to the widespread use of a covering of wire mesh similar to American fencing. The mesh was rolled out over the runway, the edges and ends of the rolls were fastened together, and the entire mat was stretched both sidewise and endwise. In the stretched position it was secured by stakes around the entire periphery.

As the weight of bombers increased, the wire mesh had to be reinforced by lacing $^3/_8$-in. round bars at 8-in. spacing transversely through the wire mesh rolls. These bars had loops welded on their ends so that adjacent rolls could be attached to each other by means of lacer bars. The resultant surface had a continuous connection fashioned similar to belt fasteners.

© *Army Air Forces*

GUADALCANAL AIRFIELD—NATIVES CARRY PLANK TO FINAL POSITION WHILE MARINES LAY AND INTERLOCK UNITS

MAT IN PLACE; SPRING CLIPS BEING DRIVEN TO KEEP PLANK INTERLOCKS SECURELY IN POSITION

AERIAL VIEW OF STEEL MAT LANDING STRIP IN USE BY OUR ARMED FORCES

Where soft spots developed, cocoa or rush mats and even planks were placed under the mesh. This mesh altered the appearance of the grass areas very little, so that the location of a runway did not become apparent until after it had been used for some time. Considerable quantities of this wire mesh landing mat, as improved by our Army Engineer Board, have been purchased and used in suitable locations by the Army Engineers.

The French, having a major part of their level land under cultivation, required a more rigid mat and naturally developed the stiffer bar-grid type. They employed flat bars, set on edge and bent to a zigzag shape, welded to flat-bottom runner bars. The Army Engineer Board improved this so-called Chevron Grid by substituting tees for the bottom bars. However, flight tests disclosed some undesirable characteristics, and this design was abandoned.

Then the Army Engineer Board developed a grid consisting of flat bars placed on edge 4 in. on centers, with round bars crosswise at the same spacing and welded to the top of the flats. A few round bars are also welded on the bottom. The edges of the units are connected by split ring connectors. Large quantities of these bar grids have been used by the Army Engineers in many varying and suitable locations.

In 1939, when the Carnegie-Illinois Steel Corporation representatives were approached on this problem, the question of availability of steel was foremost. It was apparent that if the need for landing mats should develop, they would be required in enormous quantities. At that time the lowest manufacturing load was on the structural and continuous strip mills, so it appeared desirable, other things being equal, to develop designs suitable for fabrication from the output of those mills.

It was also considered desirable to develop a general purpose mat—that is, one that could be used over the widest range of soil conditions and by all types of planes. This reasoning later led to the use of a sheet surface plank so that the maximum sustaining capacity of the underlying soil could be utilized.

First thoughts were directed toward a light-weight side-locking sheet-piling section. However, the lightest weight that could be rolled, about 10.6 lb. per sq ft, was far above the specified allowable weight. Next considered were ribbed tunnel liner sections stamped from heavy sheet metal. To connect and again detach such sections around all four sides required rather complicated and slow devices so this idea was also abandoned.

For a period of several months numerous designs were submitted by numerous other manufacturers, as well as by the Carnegie-Illinois Steel Corporation. Many devices met nearly all requirements except that of the independent removal of an individual section. Virtually all the steel panel designs required disassembly of the entire mat up to the section to be removed, or else the removal or loosening of many loose bolts, nuts, pins, or complicated clips and tight connectors.

Finally the idea of a specially devised bayonet hook and slot interlock along the edges of a ribbed flat tunnel liner segment was conceived. This idea was ultimately developed into the long and relatively narrow ribbed pierced steel plank.

By putting bayonet hooks along both edges of one plank with all bayonets pointing in the same direction and slots along both edges of alternate planks, it was possible to drop the bayonet hooks of the male plank into the slots of the adjacent female plank. Then moving the hooked plank longitudinally a short distance, less than 2 in., gave a positive interlock of great strength and flexibility. This form of interlock permitted large tolerances in the hooks and holes, which facilitated the rapid laying and assembly of the mat even under most unfavorable conditions. The bayonets were held from backing out of their slots by locking spring clips which were inserted, a few to a plank, in the slots behind the bayonets after they were in their advanced locked position.

To remove any plank, it was necessary only to withdraw the spring clips, slide the male plank back a short distance to unhook the bayonet prongs, and then lift it out. Enough clearance was left in the bayonet hooks so that the end of the male plank could be lifted up slightly and slid over the end of the next plank. When a small group of the upper alternate hooked male planks were removed, the lower slotted female planks were, of course, free on the ground and could be lifted out of position or removed at will. Replacement was just as easy and in reverse order.

© *U.S. Marine Corps*

HENDERSON FIELD FLIGHT STRIP IN USE BY FLYING FORTRESS

The next development combined slots and bayonets on both edges of the same plank. This eliminated the need of two kinds and required only one type—the universal steel plank. This has many advantages from a military standpoint. In using the universal plank it is necessary to have the bayonets in alternate rows pointing in opposite directions so that longitudinal movement of one plank for removal results in a complementary unhooking of the bayonets on both sides of the plank. In other words, moving a plank in one direction has the same effect as if its adjacent plank were moved in the opposite direction.

As a last refinement, it was felt that the steel plank did not need a solid surface—that sufficient bearing would be left if the metal were pierced with holes. While tests on swampy ground indicated that full bearing by a solid plank was required, such a site was deemed impractical for a field because of the difficulty of maintaining parking aprons, taxiways, and repair shops.

Putting holes in the plank provided several desirable features. Rainfall would seep into the entire area instead of running down the ribs to points between the ends of the planks, thus forming soft spots at the very points where the planks lacked continuity, with the likelihood of low pockets forming at those points. The open holes also permitted the subgrade to dry out more rapidly. The depressed rimmed holes likewise provided numerous cups in the surface, reducing skidding of tires.

Where necessary to fill low spots in the runway, it would also be possible to spread crushed stone or other material over the plank and then work it into the soil by shaking the plank up and down. Finally vegetation could grow through the holes, or the underlying soil would show through. Thus a most important natural camouflaging was automatically obtained.

To be effective the holes had to be relatively large. In order not to weaken the plank they had to be flanged so that the bending strength of the flanges would equal that of the metal punched out. The depth of the flanging was also critical. It had to be deep enough for strength, yet not so deep as to entrap water under the ribbed portions of the plank. It was found that a flange not over half the depth of the rib would be satisfactory.

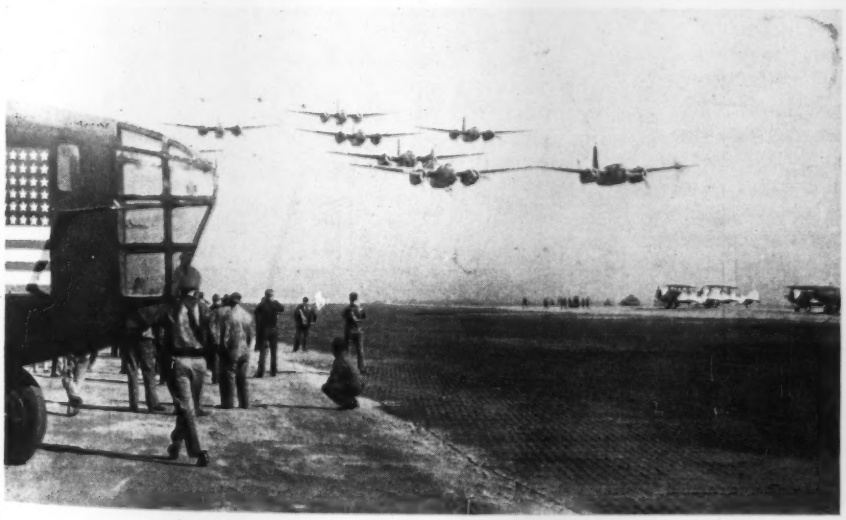
Individual perforated and ribbed steel planks each cover an area 15 in wide by 10 ft long and weigh a little more than 5 lb per sq ft, or about 63.5 lb per plank. These planks are one-piece stampings with integral interlocking and fastening devices along both edges.

For heavy bombardment ships the standard strip is about 5,000 ft long by 150 ft wide. Strips as short as 1,500 ft and only 90 ft wide are used by pursuit ships. In emergencies even smaller strips have proved effective. In one interesting case in the tropics, two individual flight strips only 10 ft wide were laid, each for one bomber wheel; they were about 1,000 ft long. These strips enabled a Flying Fortress to get off the beach after a forced landing.

The design has lent itself readily to mass production. Since Pearl Harbor twenty-nine manufacturing plants in widely separated areas have become engaged in its production. This mat has also proved its practicability from the standpoints of compactness in bundling, as it requires minimum of shipping space.

Some of the accompanying views show the manipulation and use of the mat by our armed forces under widely varying conditions of climate and terrain in all parts of the globe. It was on the spot and did its job when and where needed.

Under the name USS Air-Dek, this steel mat has been patented by the Carnegie-Illinois Steel Corporation, but other companies have been licensed to manufacture it. In fact, the 28 licensed fabricators include 5 steel producers or their subsidiaries. This collaboration accounts for the prompt use and widespread success of this war material.



BOMBERS IN FORMATION FLYING OVER LANDING STRIP

Engineers' Notebook

Ingenious Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

Marginal Drains Provided for Runways at a Naval Air Station

By WILLIAM W. OLMSTEAD, JUN. AM. SOC. C.E.
LIEUTENANT, CEC, U.S. NAVY, PHILADELPHIA, PA.

ONLY six months elapsed between ground breaking and completion of a certain naval air station in continental United States. So that rapid repair of damaged runways could be accomplished, the design provided a flexible runway. Because of the large amount of paved surface (70 acres) to be drained rapidly and because of the grades of those surfaces, a drainage system capable of handling large amounts of water very quickly was essential. It was also necessary to handle

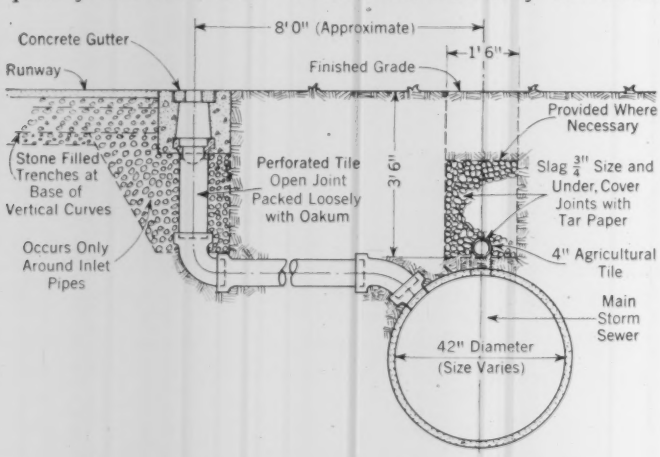


FIG. 1. MARGINAL DRAIN FOR AIRFIELD RUNWAY

the underdrainage of the runways thoroughly and expeditiously because of the impermeable soil condition and potential damage from freezing and thawing.

Where the runways sloped in one direction for their entire width, a continuous concrete gutter 9 in. deep and 7 in. wide was installed along the lower edge. This gutter was constructed with a slotted removable precast concrete cover and was also provided with laterals leading to a paralleling sewer (Fig. 1). If the turf beyond this gutter sloped towards the runway, a blind French drain was provided running along the top of the parelleling sewer to intercept subsurface water before it penetrated beneath the runway. Where the turf on the high side of such a runway sloped toward the runway, a French drain with a perforated tile pipe at the bottom was used to catch the surface water from the adjoining turf and also to intercept subsurface water before it penetrated beneath the runway (Fig. 2).

The tops of these French drains are 6 ft wide and composed of tar-coated $1^1/_2$ to 2-in. stone in order to give a permeable surface as well as to eliminate the risk of damage to airplanes, which might accidentally roll over the French drains, and to prevent individual stones from being uprooted and scattered by propeller wash. Where the runways are crowned, a gutter and drainage, such as shown in Fig. 1, were used. Subsurface drainage of the runway beds themselves was provided by shallow 1-ft ditches in the subgrade. These ditches were filled with the base material and pitched to the laterals from the concrete gutters to the paralleling sewer. The water from these drains enters the laterals through the open joints of the vertical pieces from the gutter and through perforations in the vertical pieces. This design was of inestimable value during the construction period in providing quick drying out of the base of the runways when they were subjected to rain before the surface was applied. Despite the presence of the drains, every effort was made to secure a dense and impenetrable runway surface to prohibit the entrance of water.

In designing the piping of this drainage system a runoff of 100% was used for the paved surface and 20% for the turf areas. The water so collected was carried away from the field through two large and one small outfalls. The maximum time of concentration from turf to outfall is 22 min. The capacity of the system is based on an intensity of rainfall of 5.4 in. per hour at the beginning of the drainage piping and 3 in. at the outfall. Reinforced concrete pipe was used in the large lines, and both perforated and plain vitrified tile pipe was used for the smaller lines. In addition to draining the runways themselves, it was necessary to provide a few catch basins in the low spots of the turf areas.

All the equipment employed in construction of the airfield, except that used for fine grading, was worked on two 10-hour shifts—2 a.m. until 12 noon, and 2 p.m. until 12 midnight. As much of the fueling and servicing as possible was done during the two 2-hour periods between the shifts by a truck-mounted automatic-lubrication unit and fueling trucks. This mobile servicing saved a great deal of time by keeping the equipment at the site of its work at all times. The shift arrangement just outlined necessitated approximately 3 to 4 hours of night work in each shift, which was very adequately accomplished under floodlights. The policy of having each shift do a portion of the night work was very satisfactory to the personnel. Also, since the difference

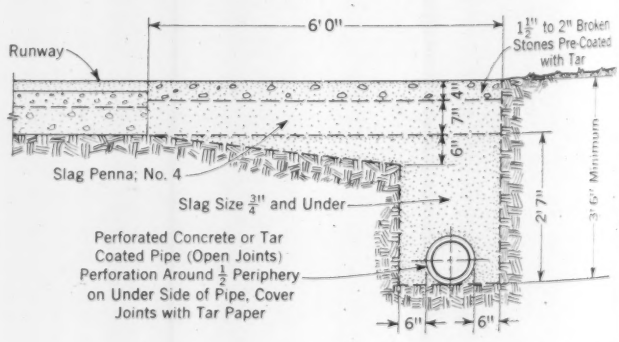


FIG. 2. FRENCH DRAIN INTERCEPTS FLOW TOWARD RUNWAY

between the efficiency of the night work and the day work was negligible, the apparent weakness of the system in wasting two hours of daylight was nullified. Furthermore, under this two-shift arrangement the high-salaried supervisory personnel, working a normal daylight shift, had immediate control over the foremen and men of both shifts, and the work of one shift was doubled with little increase in overhead cost.

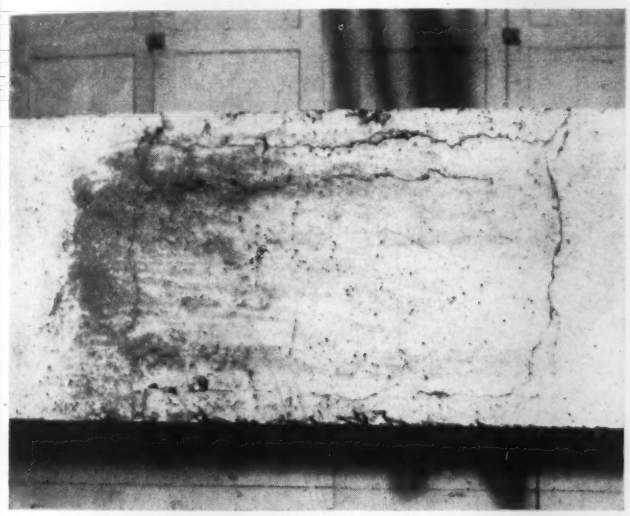
The drainage piping was installed as the rough grading progressed. The concrete gutters were poured, following the fine grading and before the placing of the base material. There was some concern lest the extensive rolling operations might affect the concrete gutters; however, this proved to have no basis. Before the French drains were installed on the high sides of the runways, paralleling temporary ditches were dug beyond them to keep surface water from the unseeded areas from washing in fine material. These ditches were maintained and used until there was a sufficient stand of grass to prevent this movement of fine material.

The Air Station was designed by The Ballinger Company, Architects and Engineers. Irwin and Leighton were general contractors. The writer was Resident Officer-in-Charge of the construction.

Load Test of a Slab with All Bars Lapped

By HOMER M. HADLEY, ASSOC. M. AM. SOC. C.E.
REGIONAL STRUCTURAL ENGINEER, PORTLAND CEMENT ASSOCIATION, SEATTLE, WASH.

TO investigate the effect of lap-splicing reinforcing bars, arrangements were made to form and test a small concrete slab with all bars spliced at mid-span. The investigation was made in the testing laboratory of the City of Seattle, Wash.



CRACK PATTERN ON BOTTOM OF SLAB EMPHASIZED BY OVERLOAD

This slab, Fig. 1, was 15 in. wide, 4 in. deep, and 9 ft 0 in. in length. To avoid the inconclusive tension failure that would inevitably have attended the use of an ordinary percentage of reinforcement, the slab was reinforced with five deformed bars $^1/_2$ in. square. These bars were in two pieces, which lapped 40-bar diameters—that is, 20 in.—at midspan, all laps being squarely opposite one another. The bars were given $^1/_2$-in. cover and were centered $^3/_4$ in. above the bottom, making an effective depth of $3^1/_4$ in. and the steel percentage 2.56. Except for two $^3/_8$-in. round transverse spacer bars, no transverse steel of any kind was used.

The laps were made by placing the companion bars in as close contact as their lugs would permit and wiring them together at two points with the soft wire commonly used in tying reinforcement in position. A standard 6 by 12 cylinder, made of the concrete used in the slab—1 to 6 mix—gave a 28-day compression strength of 4,390 lb per sq in. The reason for making the test with a slab rather than with a beam was to have a specimen subject to large distortions and, in all respects, of as unfavorable type as possible.

The slab was tested on an 8-ft 0-in. span, subjected to two equal loads, 22 in. apart, symmetrically placed with respect to center line. It sustained a maximum total applied load of 9,410 lb. The type of failure was not immediately apparent from the cracks that developed in the sides of the slab, some of which suggested bond failure while others might well have resulted from tension failure in the steel. To emphasize the cracks the load was forced down upon the slab until it had taken a permanent deflection of $1^3/_8$ in. resulting in rather sharp angular bends at the load points. The slab was then removed from the machine and turned upside down, revealing the very interesting pattern of bottom cracks shown in the accompanying photograph. However, the issue was still in doubt inasmuch as the marginal longitudinal cracks seemed to indicate a bond failure, whereas the sharply defined transverse cracks coming opposite the ends of the lapped bars seemed clearly to indicate a tension failure.

The stresses in the slab under maximum load were high. With the 2.56% steel, d effective $3^1/_4$ in., and n assumed to be 8, kd is 1.30 in., and jd is 2.82 in. The moment of external load and dead load is 180,000 in.-lb. $T = C = \frac{180{,}000}{2.82} = 63{,}830$ lb which, if all bars are assumed to be effective, gives a unit stress in the steel of 51,000 lb per sq in. This is not the yield point of the reinforcement, which was of new billet stock, intermediate grade, having an average yield point of 55,000 lb per sq in. Should one bar slip, however, the unit stress in the remaining ones shoots up to 63,830 lb per sq in. and a tension failure will follow.

In an endeavor to determine positively what had occurred, the concrete of the slab bottom was chipped away

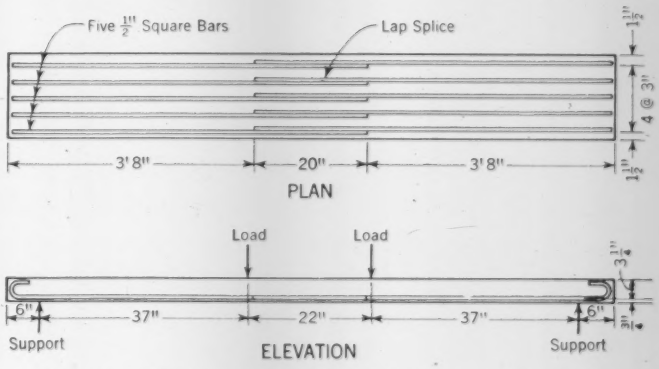


FIG. 1. ARRANGEMENT OF SPLICED BARS IN TEST SLABS

along the marginal and transverse cracks to expose the surfaces and ends of the reinforcing bars. The only noticeable feature to be observed was a slight gap, about $^1/_{50}$ in. wide, at the ends of the inner bars and nearly $^1/_{32}$ in. wide at the ends of the marginal bars. It was judged that in all probability these gaps were created when the heavy permanent deflection was impressed upon the slab by crowding it down after maximum load had been attained. No other evidence of slippage could be definitely identified by visual inspection.

A very simple and positive test—forming a small globule of water with an eye dropper where the side of the reinforcement came in contact with the concrete—was then used. If the slightest slippage had occurred and bond was broken, the water immediately sank into the minute gap at the side of the bar. Otherwise, it stayed on top. Pronounced slippage was thus discovered along the outer bars, although the inner bars of these lapped pairs had not moved. With the three inner pairs of bars no movement or slippage of any kind had occurred.

It was concluded that the primary cause of the failure, at the steel stress of approximately 51,000 lb per sq in., was by bond—319 lb per sq in.—in the outer bar of the pair on the north side of the slab. With the effective steel area reduced 20% by this failure, the stress in the remaining bars immediately passed the yield point. It is significant that the three innermost pairs of bars, possessing the lateral confinement and embedment which the outer bars lacked, did not fail in bond although the steel was stressed to and beyond its yield point. It is not so significant that the inner bars of the two outermost pairs did not slip or fail in bond for the reason that as soon as the outer bars failed they were largely relieved of stress.

Sectional Steel Buildings of Rigid-Frame Type

By C. HAROLD LOUREE, ASSOC. M. AM. SOC. C.E.
DISTRICT MANAGER, THE INGALLS IRON WORKS COMPANY, NEW ORLEANS, LA.

THE first sectional steel buildings were made especially for use in the oil fields, where the life of a building in one location is sometimes very short. A sectional building with side and end panels covered with corrugated iron could be taken apart and moved to a new location and reerected in a very few hours' time. In the past sectional steel buildings have been limited to truss-type construction. Trusses, by limiting the headroom, interfere with certain types of equipment, such as large presses and conveyors. However, buildings of the same over-all dimensions with rigid frames clear such equipment. Also the ribs present no obstruction to light.

A sectional steel building must be easily erected and dismantled, preferably with bolted connections. The use of the conventional all-welded rigid frames would be impossible because such frames could not be readily dismantled. This difficulty is overcome by providing bolted connections in the frames (Fig. 1). All members of the bent are made of rolled wide-flange sections. Field splices are provided in the rafters on each side of the frame, at points of minimum bending moment.

At the inner corner of the knee at the junction of the beam and column, where compression stresses are concentrated, the flanged areas are reinforced with triangular plates, which distribute the compression stresses of the inner flange into the beam web while the compression in the bottom flange of the beam goes into the column web.

Since fixed bases remain fixed only in theory and it is impossible to be sure of foundation conditions for a sectional building, the two-hinged arch design is best for the frames. Base plates are first punched for anchor bolts, then shop welded to the columns. Welds are necessary only on the flanges of the columns, and any additional welding is wasted.

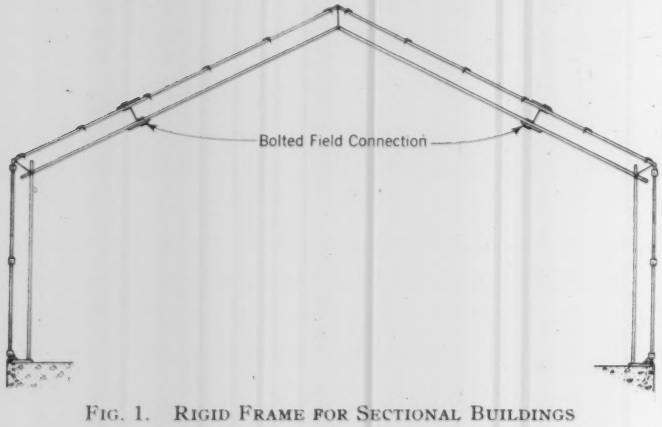


FIG. 1. RIGID FRAME FOR SECTIONAL BUILDINGS

A SHEET-METAL SECTIONAL BUILDING WITH RIGID FRAMES

Each frame was fabricated and shipped in three pieces—two column-and-knee sections and one center section—with the ridge joint and knee joints shop welded. These joints were made by cutting the beam on the required bevel, after which one piece was turned over and the two pieces were then butt welded together again. This was done to cut down the amount of flame cutting and fitting that other joints required. Also, some metal was saved.

The steel is quickly erected with an "A" frame mounted on a winch truck or by other simple equipment. The column-and-knee sections of the frame were set in place and held by the base-plate anchor bolts. The center section was then placed and secured with 16 bolts, four in each beam flange at each splice. The splice plates were so welded in the shop that they provided convenient temporary support for the center section and allowed it to be lowered vertically into place.

[This article has been abstracted from a paper by Mr. Louree, which won an award in the most recent James F. Lincoln Arc Welding Foundation competition.]

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Our Engineering Standards Must Be Reappraised

DEAR SIR: Mr. Green's article on "The Slums in Engineering," in the July issue, is of much interest and should cause some concern to those entrusted with educational programs.

The war has created an immense interest in the technically trained and has been instrumental in the development of a multitude of training programs. The majority of these programs are of a standard far below that of the average educational institution and should find little to justify their existence, notwithstanding the fact that their graduates are readily absorbed by industry.

The elimination of these slums is the responsibility of the educator and the profession alike. Educational standards cannot be placed on a sliding scale adjusted to the economics of the day, nor should the profession close its eyes to the situation and be complacent about the outcome.

The young men entering the profession are not responsible for the situation and should not be expected to provide the solution. Their ambition, perseverance, and determination will not remedy the situation and may even aggravate it. Their dissatisfaction with life in the subprofessional ranks might result in a move to seek advancement by mere weight of pressure and not professional attainment.

We must take time to put our professional house in order, to reappraise our educational standards and objectives, and to inquire into the professional obligations of the engineer to his juniors and to the public.

A. A. K. BOOTH, M. Am. Soc. C.E.

Spring Hill, Conn.

The Remedial Weir in Niagara River

TO THE EDITOR: In his paper in the August issue Mr. Cline described some of the hydraulic conditions of the Niagrara River from its source to Lake Ontario, which have a bearing upon the building and functioning of the remedial weir. As he pointed out, all the water used for power purposes on the American side, as well as the water used by the Queenston hydroelectric plant—the largest one on the Canadian side—is diverted from the Chippawa–Grass Island Pool. Thus the maintenance of a specified minimum level in the pool for a given river stage at Buffalo is important from the standpoint of power development.

The Chippawa–Grass Island pool is about 7,000 ft wide, and though it is called a "pool," its average depth is less than 10 ft and its slope is greater than that in the channels above. From an analysis of conditions at the pool and the proposed weir, it was apparent that a pre-determination by computation of the exact rise in pool level resulting from a particular weir design was not possible. It was, therefore, decided to fix the design as the work progressed and as successive observations were made on the effect of the construction.

To relate the water level rise at a point in the pool to the construction work and, in so doing, to eliminate the influence of any changes in diversion and in river stage, Mr. Cline ingeniously developed some gage-relation formulas that were found useful during the work. Equation 3 of his paper compares water levels obtaining at any given gage with levels after a change in regimen takes place.

It should be noted that the coefficient a is not strictly a discharge coefficient, as it has been designated by Mr. Cline. It is the multiplier of the gage height, a magnitude of length and not one of discharge. Similarly, the diversion cofficients b and c are strictly ratios of length to discharge. This comment is made in order to point out the true significance of these factors.

As a check on Mr. Cline's method, the writer compared it with a graphical method of determining change in stage, applied to the Rankine diversion weir built in the Canadian channel of the Niagara River below the first cascade in 1938 to restore the water level in the forebay of the Rankine Hydroelectric Station, which had been lowered by increased diversions upstream. The graphical method consisted of establishing stage–discharge curves for the natural channel and the channel with the weir constructed. The changes in stage due to the weir construction obtained from these curves were in close agreement with results from gage relation formulas developed by Mr. Cline for this particular job. It should be noted, however, that the graphical method does not take account of the change in distribution in the channel due to the changes in diversion of any of the power plants and is, therefore, more approximate than Mr. Cline's method.

As a second check on the method, an independent study has been made of the equation for the change in gage height at Grass Island, based upon observations of hydraulic data for the months from May to November 1932, and in this study Gauss's method of solving normal equations was used. The same working equation as given by Mr. Cline for the change in stage occurring at Grass Island was obtained.

Further, as a check on the discharge coefficient a in Eq. 3, given as 0.217 for Grass Island in Eq. 4, the writer derived this coefficient independently as follows: Shenehon in 1912 found that a change of 1 ft. as Buffalo corresponded to 0.56 at Grass Island, and since this corresponds to 2.77 ft at Morrison Street gage, the coefficient a for Grass Island is approximately $\frac{0.56}{2.77} = 0.202$.

A model of Niagara Falls built by the Niagara Falls Power Company in 1923 and 1924 was used to test various remedial works in the Niagara River. One of the works tested was the proposed submerged weir in the Chippawa–Grass Island pool. While the model tests cannot be used to determine accurately the increase in level to be expected from the weir construction because of inaccu-

MODEL OF NIAGARA FALLS CONSTRUCTED BY THE NIAGARA FALLS POWER COMPANY
Remedial Weir Shown Above Cascades

rate sounding data available at the time of the tests, they can be used to indicate general results. They showed that the flow over the American Falls was increased substantially, that the distribution of the water over the crest of the Horseshoe was improved with more water passing over the edges, and that the pool level was increased.

The building of the remedial weir is the first step in the attempt to improve the beauty of the Falls, though additional work may be done in the future for the development of power and the improvement of the scenic spectacle.

E. B. STROWGER
Hydraulic Engineer, The Niagara Power Company

Niagara Falls, N.Y.

Forum on Professional Relations

CONDUCTED COLUMN OF HYPOTHETICAL QUESTIONS WITH ANSWERS BY DR. MEAD

For the past year Dr. Mead has been answering questions on engineering ethics in these columns. Currently he gives his views on Question No. 12, which was announced in the July issue. The question states that: "A young engineer is employed by a municipality at a salary of $3,000 per year. Would the engineer be justified in doing private work during his spare time and in retaining the payments for this work for his own use?"

This question, like many ethical questions, does not give sufficient information to admit of a categorical reply. In many small municipalities the work of a city engineer is not sufficient to require the engineer's full time.

In the writer's early experience, he was appointed as the first city engineer of Rockford, Ill., then a small city of about 25,000. Neither the city authorities nor the writer understood what was really required of a city engineer, and the writer was employed on a per diem basis with the understanding that outside of the requirements of the city his time would be used as he found other work. In the three years in which he served in this position the duties of the office became more apparent and, upon his resignation to go into other work, his successor was employed on a salary basis and was expected to put in all his time on municipal work.

In general, the writer thinks that a fixed salary usually anticipates the full time of the recipient but this is not universally true. From 1904 to 1932, the writer was employed as professor of hydraulic and sanitary engineering at the University of Wisconsin. This employment was on a salary basis, but with the distinct understanding that the writer should continue his work as a consulting engineer. Indeed, this continuance in private practice was desired by the university authorities who wished to have some one in practice in contact with the engineering students; and during the writer's services at the university he had at times as many as thirty engineers employed in his private office.

In all such cases, a distinct understanding of the details of the contract should be established at the time employment is entered into. Under such circumstances there would be no question as to whether or not outside work is to be done by the city engineer, and if it is done, whether the returns shall go to the city or to the engineer. A great many troubles and disputes arise from a lack of detailed understanding of both verbal and written contracts, and such trouble can be readily eliminated if attention is given to all points likely to arise during the time a contract is in force.

DANIEL W. MEAD, Past-President and Hon. M. Am. Soc. C.E.

Madison, Wis.

Other problems of professional relations will be treated by Dr. Mead each month. Next in sequence for study and written discussion by members until October 5, with answers in the November issue, will be the following:

Question No. 14: An engineer in general practice was retained by a client to prepare plans, estimates, and specifications, and to inspect and superintend the construction of certain works. In this capacity the engineer became the interpreter and arbiter of the contract and specifications. The contractor who had taken the contract, realizing the experience and ability of the engineer in his specialty, desired to employ him at the same time on another project of a similar nature which he had in view. The engineer had ample time for both jobs. Should he have accepted or rejected the contractor's offer?

Exceedance or Recurrence Intervals in Analyzing Flood Discharge

TO THE EDITOR: In connection with Mr. Powell's article on "A Simple Method of Estimating Flood Frequency," in the February issue, and the discussion on it, my method of solving such problems has been mentioned. The question has been raised as to whether within my method of dealing with the flood discharges, the exceedance or recurrence intervals ought to be used as observed return periods.

This problem arises within any statistical theory and may be put in the following way: Shall we use m/n or $(m - 1)/n$ as observed frequency of the m'th among n observations?

In a contribution which appeared in the June issue of the PROCEEDINGS of the Society, I have shown that instead of either method the probability $(m - \Delta)/n$ of the most probable m'th value ought to be chosen for the observed frequency of the m'th observation. This leads to adjusted return periods $n:(n - m + \Delta)$ which may be called occurrence intervals. The correction Δ depends upon the theoretical distribution chosen for representing the observations.

For Fuller's theory, this method prescribes the use of the recurrence intervals. For all distributions which possess a mode, the occurrence intervals pass for increasing values of the variate from the exceedance intervals to the recurrence intervals. For the theory of largest values the occurrence intervals for increasing numbers of observations and for large floods converge rapidly toward the recurrence intervals. As the small floods are usually not very interesting, the general use of the recurrence intervals is legitimate for estimating flood frequencies interpreted as largest values.

E. J. GUMBEL

New York, N.Y.

Binding Old Concrete with New

TO THE EDITOR: In the August issue (page 391) Walter F. Shaw, Assoc. M. Am. C.E., writes that some thirty years ago he discovered he "could get a perfect bond between new and old concrete by treating the old concrete with dilute HCl," and expressed his surprise "to find that very few engineers and constructors in general know about it."

In 1907 I published a short article on "Bonding New Concrete to Old," by means of using muriatic acid diluted with water 1:3. My idea was used by A. C. Horn, who sold a material he named "Bonsit." Ransome also sold a similar material he called "Ransomite." Both were powdered muriatic acid crystals.

ALBERT MOYER, Affiliate, Am. Soc. C.E.

Canadensis, Pa.

SOCIETY AFFAIRS

Official and Semi-Official

Postwar Construction

Planning Now Will Safeguard National Economy in Critical Transition Period

ADOPTED BY THE BOARD OF DIRECTION, AMERICAN SOCIETY OF CIVIL ENGINEERS, JULY 29, 1943

THE IMMEDIATE preparation of a construction program for a peacetime economy is essential. This is true despite the fact that America is engaged in total war. Herein is outlined such a program of action in preparation for construction directly following the war. This program proposes both private and public construction projects of unquestioned usefulness, and activities to be undertaken now in order to insure a sufficient volume of construction immediately after the release of manpower from the armed services and war production activities, so that a share of this manpower may be quickly absorbed in peacetime construction.

The American Society of Civil Engineers, over ninety years old, is composed of nineteen thousand members united in support of the highest professional ethics and sound engineering practices. They serve in industry, in consulting practice, and in engineering departments of federal, state, and local governments, with widespread geographical distribution. The Society now dedicates itself to the furtherance of the objectives here presented. It offers to the government and the people of the United States its facilities and the accumulated knowledge of its members in working out the practical procedures needed. It offers the cooperation of its Local Sections and of its members in interpreting this program to public and private agencies and in stimulating local activity and specific action consistent with the proposed program.

Our country is engaged in a war to preserve American ideals and liberties. Victory is our primary objective, regardless of its cost. Our wealth, our resources, and our citizens are now wholly committed to this righteous cause. True patriotism, however, transcends wartime fervor—it also demands adequate planning for peace. Any less enlightened concept amounts to betrayal of those making the greatest personal sacrifices to win the war.

Fortunately, leaders in government and industry and the professions are giving serious study to the problems which will face our people when the war is won, when war production ceases, and when our armed forces are demobilized. But study must go beyond wishful thinking; it must proceed to action *now* to insure favorable economic conditions *then*.

THE CONSTRUCTION INDUSTRY AVAILABLE

In large measure the gigantic job of war construction is accomplished. The volume is rapidly reducing, so much so that soon this activity will be almost at a standstill. This means that shortly there will be available a large number of experienced engineers and architects whose services could be usefully employed in the preparation of detailed plans and specifications for useful postwar construction projects. Many of these men are above military age or incapable of combat duty. Their technical training and engineering experience are so valuable that it would be criminal to waste their talents on routine work or manual labor in war production plants. No wiser use could be made of these engineers and architects than in assigning them to make detailed plans and specifications for needed projects to be let to contract promptly after cessation of hostilities.

The construction industry consists not only of engineers and architects but also of contractors. By training and experience this group is most competent to plan, supervise, and execute construction projects with economy and dispatch, and to secure the maximum return for the dollar invested. The contract system long since has demonstrated its merit; it should be employed for both public and private construction. The construction industry is the liaison through which individuals, business, and the governmental agencies representing the public, on the one hand, and manufacturers of machinery, producers of materials entering into construction, and construction labor, on the other, cooperate to produce useful works.

INDUSTRIAL CONSTRUCTION

Industry, considered broadly, not only has performed a miracle of war production but also is exercising most enlightened leadership in planning to meet postwar problems. Through the Committee for Economic Development, and other similar organizations, the best minds in the fields of business, economics, and research are developing tangible plans for prompt conversion from war production to the making and marketing of peacetime products—thus to provide useful jobs for workers. Prompt conversion to peacetime production will satisfy the pent-up postwar demand for durable and consumer goods growing out of accumulated wartime scarcity and accumulated war-time personal savings.

An essential part of this industrial activity is the alteration or construction of plant facilities to make for most efficient production units in the postwar period. Obviously, the preparation now of detailed plans and specifications for such construction will speed up greatly its execution immediately after the war and shorten the period required for conversion to peacetime production.

War production has necessitated a very large expansion of plant facilities. Many new war plants may be suitable for conversion to peacetime production, while others of purely war utility may be ultimately dismantled. Many older facilities have become obsolete and will require radical modernization or replacement.

Illustrative of new private industrial construction to be undertaken are: Plants for production of durable and consumer goods; deep freeze food storage plants and individual food lockers; stock yards and packing-house facilities; warehouses; grain elevators; mining structures; railroad terminals, freight and passenger depots, bridges, and tract improvements; oil pipe lines, pumping stations, and refineries; airports for civilian operations; public utility plants—electric power, gas, water, steam, etc.; and stores, hotels, and office buildings.

HOUSING

Even before the war there had developed a large potential demand for private homes. To make matters worse the restrictions on civilian construction imposed during the war period have arrested also normal home building. This acute demand for new private housing can be expected to manifest itself in intense activity as soon as wartime limitations are lifted. This is true notwithstanding the large volume of housing projects built recently for war workers. In general these are but "bare subsistence" dwellings—a large percentage are not properly located or attractively designed for peacetime living.

Home buying habits are thoroughly entrenched. There is great resistance to radical departure from customary styles of architecture and methods and materials of construction. While new designs, materials, and construction methods will attract interest in the postwar period, their wide acceptance will probably be gradual. Neither history nor probability justifies the expectancy that people will wait for the "perfect house of tomorrow" or that such a house, if available, would be generally accepted at once.

Every effort should be made by organizations of realtors, by chambers of commerce, by labor organizations, by financing organizations, and by all other business groups serving this particular field to stimulate these potential home buyers to acquire their land and to complete their plans and specifications now so that they will be in position to contract for home construction immediately following cessation of hostilities.

Residence modernization and farm home and farm building construction will provide an additional stimulant to the postwar economy.

The general demand for better housing will express itself also in the construction of individual apartment buildings and two-to-four-family unit dwellings. It will encourage the construction of large housing developments, embodying park areas, playgrounds, central heating plants, and apartments in a general plan to afford to the occupants the maximum of beauty, light, air, recreation, and home atmosphere. These developments will spring up in hitherto undeveloped areas and in the congested, decadent areas of the larger cities. Probably, in large measure these will be financed privately.

Industrial construction and private housing account for approximately two-thirds of all construction activities, the remaining one-third being classified as public works.

PUBLIC WORKS

Present Planning Necessary. An annual program of useful public works construction is required in normal times to replace obsolete or worn-out facilities or to provide the new facilities demanded by advancing or changing American standards of living. These are just as essential as are the products of private industry. They are frequently a prerequisite to maximum individual enjoyment of privately purchased products. The interdependence of the privately owned motor car and the publicly built highway illustrates this point.

During the war years, civilian construction has been necessarily curtailed. Thus in the postwar period the accumulated demand will be aggravated by the normal yearly need for useful public construction.

G. DONALD KENNEDY

It is true that a large number of useful jobs can be made available in industrial production and distribution and in privately financed construction immediately following the war. Nevertheless, there is grave probability that the millions of war workers and demobilized service men cannot be absorbed in usual occupations at a sufficiently rapid rate to prevent serious unemployment. This country cannot afford to see again bread lines, public soup kitchens, and an army of war heroes peddling apples on the streets in a pitiful attempt to eke out a livelihood. Such conditions generate social unrest and, if allowed to persist, may threaten the very form of government and the system of free enterprise for the preservation of which every sacrifice is now being made.

It is imperative that steps be taken now to insure against these conditions. Presumably those in the armed forces will not all be demobilized simultaneously. Instead, this process may take place over a period extending up to two or more years. Possibly the optimism of those who maintain that industry and private endeavor can absorb all those seeking new jobs in the postwar period may be realized; but there is too much at stake to warrant risking the future of America on these possibilities.

A program of useful public works that may be constructed immediately after the war should be planned now to insure against the development of a critical unemployment situation. This is especially true since these works not only will provide employment but are actually needed for the daily use of everyone. Unless preparation for such a program of useful construction is made now there may arise in the postwar period a demand for a made-work program primarily social in its objectives. Such a made-work undertaking would not add measurably to the wealth of the country. Conversely, it would pile on top of a gigantic war debt a tax burden which would involve enormous additional federal expenditures for the relief of needy citizens.

A program of present planning for useful and economically sound public projects with prepared detailed drawings, specifications, contract documents, and other preliminaries is essential. Contracts can then be let so as to provide flexibility in the feeding of construction projects into the nation's economy as the facilities are needed or as such work is required to provide useful jobs.

Long-Range vs. Short-Range Planning. In planning for postwar public works two basic views are held.

One group is thinking primarily in terms of long-range programming designed to change ultimately the faces of the cities of America; to interlace the country with a tremendous system of superhighways; to develop great conservation projects for flood control, for reclamation of waste lands, and for the production of power; to revamp the terminal facilities and operations of the railroads; and to develop great airports and terminal facilities for air transport.

To the extent that the projects are sound such thinking is most commendable and should be encouraged as a continuing procedure. Common sense dictates, however, that these broad and long-range concepts can be fully planned and realized only over periods of perhaps from twenty-five to fifty years. It is inconceivable that such long-range projects can be financed and brought to the construction stage with sufficient promptness to meet immediate postwar needs.

The other group of planners is visualizing primarily a shorter range and, consequently, a more realistic approach. It is thinking of projects needed promptly and of the helpful part construction can play in the critical period immediately after the war.

The most casual survey will reveal that an enormous volume of practical and useful public work projects is needed now for daily use. These projects would already have been under way had not war intervened. They are of a type which would fit into any long-range plans, but they have the great virtue of being needed now. Also, they may be financed on a basis which will not bankrupt the country and which will not make worse the financial problems that must be met in the postwar period resulting from enormous war expenditures.

Many of these projects are of the self-liquidating type that can be financed by revenue bonds to be retired by the beneficiaries on a "pay-as-you-use" basis. There exists a rapidly growing trend toward this method of financing public works. Other projects must be publicly financed but are of such immediate utility and necessity that they can be financed out of accumulated surpluses, by bond issues or by local taxation.

These useful projects would provide a huge total of nation-wide construction activity, readily financed and capable of being launched promptly, or as needed, to assist in providing adequate employment during the reconversion or transition period following the war. A postwar public works program of this character has double virtue: (1) The projects are needed now, are useful in themselves, and will add to the national wealth; and (2) they afford a practicable means of generating useful jobs at the proper time.

A word of caution is needed here. There are limits to the volume of employment that can be provided economically by the construction of public works. All other elements of the national economy must bear their proper share of the load. Public construction should be utilized, but not to a degree that would unbalance that economy or would stifle private initiative.

Work of this character can be placed under contract promptly after the war closes, provided the essential preliminary work is started at once and completed before the end of hostilities. This preliminary work includes:

1. Preparation of working plans, specifications, and contract documents;
2. Selection of rights of way and other necessary rights; determination of their costs; and preparations for prompt acquisition;
3. Completion of legal and financial arrangements for immediate construction.

LOCAL PUBLIC WORKS

It may be helpful to analyze the variety of facilities which constitute the reservoir of useful public works heretofore discussed. Many of them are self-liquidating in character. Others will require financing by general taxation. Some are in an intermediate zone, so far as methods of financing are concerned.

1. Self-Liquidating Projects. Most states have had laws for some years which permit the financing of certain types of public improvements on a revenue bond basis. These bonds are not a general public tax obligation but an obligation retirable out of the earnings of the projects themselves, derived from payments made by the actual users. Thousands of economically justifiable projects, both large and small, have been financed in this manner and have demonstrated their success. The procedures involved have passed the experimental stage. In this category are found, among others: Impounding reservoirs for water storage; water distribution systems; water purification plants; public swimming pools; sewerage systems; sewage disposal plants; drainage works; irrigation systems; levees and flood protection walls surrounding drainage district areas; street improvements, which are not of general use and whose primary function is to give access to private properties; toll bridges; express and limited-access highways and highway tunnels; hospitals; public-owned urban rapid transit lines; off-street parking facilities; public markets; large housing projects; and dock facilities.

The utility and economic soundness of self-liquidating projects is evidenced by the willingness of the users of these facilities to underwrite their cost on a "pay-as-you-use" basis. The potential volume of such work is enormous. Thus far only the surface has been scratched. The normal demand for such improvements is now greatly accentuated by the restrictions on their construction which necessarily have been imposed during the war.

2. Publicly Financed Projects. The curtailment of civilian construction during the war has resulted in an accumulation of deferred local projects of wide variety normally financed by the states, cities, villages, counties, and other political subdivisions by general taxation. Also, during the war period, many of these political subdivisions have accumulated substantial surpluses of funds which can be made available for the construction of useful projects.

Outstanding bond issues for public improvements have been paid off during the war period to such an extent that many of these local political units may now incur additional bonded indebtedness for needed improvements without exceeding legal limitations. Some of these improvements are of such a character that although publicly financed they approximate the status of self-liquidating projects.

Included in the wide variety of useful local projects which properly may be financed through general taxation and thus are practicable in the period immediately following the war are: Schools; parks and recreational facilities; libraries; buildings for housing local governmental agencies such as city halls, courthouses, and jails; flood-control projects of local significance; public health centers; state penitentiaries; state hospitals for the insane and feeble-minded; state homes for orphans, or the aged; buildings for state universities and other public institutions of higher learning; and public highway and urban street improvements.

This vast reservoir of potential postwar construction projects, primarily of local interest, is useful and needed.

3. Federally Aided Projects. Highways and major urban thoroughfares which are of general motor use are examples of types of public works in the cost of which the federal government logically should participate. This principle of federal aid for state highway development dates back almost to the inception of the highway movement.

For years the federal government has levied an excise tax on motor vehicles and recently has collected also a federal gasoline tax. Since both the government and the states are levying these imposts, it may be logically contended that highway and street improvements of general motor use are in essence self-liquidating projects.

During the war, military and commercial traffic has grown in intensity, maintenance of highway and street facilities has been of subnormal standard, and public highways and streets have seriously deteriorated. Prior to the war an actual deficiency existed in the highway system of the country due to inability to keep pace with the growth in highway requirements. It has been estimated that for this accumulated deficiency the sum of 3.6 billion dollars of construction, reconstruction, or modernization would be required. Meanwhile new construction, replacement of worn out highways, has been deferred for two years, adding further to critical needs. Some obvious requirements therefore are:

(*a*) Modernization and reconstruction of state trunk highways and of arterial streets in cities and villages.

(*b*) Express highways of the limited access type; off-street parking facilities; and belt lines and by-pass routes. These improvements within and adjacent to the larger metropolitan centers are designed to facilitate the flow of traffic and to synchronize with and take full advantage of the rural highway system.

(*c*) Construction of a relatively large mileage of interregional highways of national significance.

(*d*) Major improvements on the county trunk or feeder highways now officially designated as the secondary highway system.

The highway and street field presents one of the best opportunities for pre-planning of projects for immediate construction following cessation of hostilities. Fortunately, the nation-wide planning surveys made heretofore by the Public Roads Administration and by the state highway departments provide the essential data for sound planning.

4. Financing Local Public Works. It is evident that local public works constitute a crucial element. At the moment there is no assurance that preparation of detailed plans and specifications for specific projects will be consummated in time to insure that the needed volume of work can be let to contract promptly after the war. It is not enough to catalog or list these projects with approximate estimates of their costs and indications of how they may be financed. The real need is that means be provided for complete preparation *now* of actual plans and specifications and other preliminary work relating to rights of way and means of financing, to the end that, with the return of peace, construction contracts may be awarded and the work promptly gotten under way.

The projects are available, the technical talent for making the plans and specifications is available, but the vital need is for a means of financing the very essential preliminary work. Some states and localities already have demonstrated the necessary initiative and feasibility of financing such planning work through their own resources.

To meet the requirements of an adequate postwar program, such an approach must be stimulated in every state and its local subdivisions. In many states and localities where projects are available and the technical talent for this planning program is obtainable, a certain stagnation exists with respect to securing the necessary funds. This issue calls for the emergence in every locality of far-sighted leadership on the part of public officials and public-spirited citizens.

Some state or local laws or other similar obstacles may now prevent or would cause serious delay to the immediate financing of necessary planning for local public works. Where this is the case it may become necessary for the Congress to authorize a revolving fund and a system of making loans, under proper safeguards, as a means of getting such work under way. To this end, it is recommended that the Congress make available a substantial appropriation for assistance to public agencies in preparing detailed plans and specifications for useful construction projects. Obviously, no funds should be allocated for advance plans for any project until it has been reviewed by a proper agency of the federal government and an adequate showing has been made: (1) That the project is actually needed and would be useful; and (2) that it is economically sound.

Upon such a showing, the federal government might well advance a sum sufficient to cover the total cost of plans and specifications, with the provision that if and when the project is financed and proceeds to construction the amount advanced for plans, specifications, and contract documents would be returned.

FEDERAL PUBLIC WORKS

Thus far nothing has been said about the present planning of federal public works for construction in the postwar period. In part such planning is already under way, and all agencies engaging in various forms of construction for the federal government are surveying projects which profitably could be undertaken. It is recommended that appropriations be made now so that these departments may proceed promptly in preparing detailed plans and specifications. The following criteria should apply in all cases:

1. The project shall have practical utility and be economically sound;

2. It shall be of such character as not to compete with facilities provided through private enterprise.

COOPERATION ESSENTIAL

The American Society of Civil Engineers submits this program for the purpose of stimulating clear and practical thinking and constructive action on postwar construction. To this end the energetic cooperation of professional, civic, business, and labor organizations and of the executive and legislative branches of federal, state and local governments is needed and solicited. A definite program is necessary to absorb manpower released from the Armed Services and from war production. Preliminary studies, preparation of plans and specifications, arrangements for financing, and acquisition of real estate must be completed before construction can be begun. To preserve economic freedom—the freedom of enterprise, characteristic of the American way of life—the preliminary work must be done now. It will be too late to wait until the war is over.

Prepared and submitted by the
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Meeting of Board of Direction—Secretary's Abstract, July 28–30, 1943

THE BOARD of Direction met at the Biltmore Hotel, Los Angeles, Calif., on Wednesday, Thursday, and Friday, July 28, 29, and 30, 1943, with President Ezra B. Whitman in the chair, and Secretary Seabury and the following members of the Board in attendance: Past-Presidents Fowler and Black; Vice-Presidents Spofford and Stanton; and Directors Bakenhus, Breed, Carey, Cunningham, Dickinson, Edwards, Goodrich, Howard, Massey, Rawn, Requardt, Scobey, and Wiley. Regrets were received from those who by reason of business were unable to attend. There were five sessions in all, one on Wednesday afternoon and two each on Thursday and Friday.

Minutes Approved as Written

The minutes of the meeting of the Executive Committee held on April 5, 1943, and of the Board meeting held on April 6 and 7, 1943, were approved as written.

Renegotiation of Contracts

Following the report of the so-called Washington Committee, it was requested to secure from the government the application of a more uniform basis of renegotiation of the contracts held by engineers and architects for the professional services they have rendered in the war effort.

Dues of Service Men

The Board, in continuance of its previously adopted policy, approved the cancellation of 1943 dues of 540 non-commissioned members of the Society in the Armed Services and of those holding commissions for which the base pay in the United States is $2,400 or less.

Joint Conference Committee

The suggestion of the Joint Conference Committee that its membership be increased by adding the latest living president of each of the five collaborating societies was approved.

Government Consulting Fees

The Board directed that the President address to the Secretaries of War and Navy strong protests against the present provisions that compensation for consulting engineering services be limited so as "not to exceed $25 per diem."

Amended Model Registration Law

Consideration was given to "A Model Law for the Registration of Professional Engineers and Land Surveyors and Providing for the Certification of Engineers-in-Training," as amended by a conference of representatives of ten national engineering societies on May 24, 1943, called at the instance of the Society's Committee on Registration of Engineers. Special attention was given to the newly proposed provisions for the grade of "Engineer-in-Training" available to young engineers. The Board gave "approval and endorsement" to this amended document. (See July issue, page 338 for text of these provisions; and apply to the Secretary for copy of the law as thus amended and awaiting endorsement by other engineering societies.)

Alfred Noble Prize

Provision was made for the award of the Alfred Noble Prize for 1943, 1944, and 1945.

Amendment to By-Laws—"Article VIII. Technical Divisions"

The Board gave approval to an amendment of the By-Laws, changing the method of operating and administering Technical Divisions. The changes were suggested by the Committee on Technical Procedure, consisting of the chairman of the twelve Technical Divisions and the five Board members on the Committee on Division Activities. Wording of the entire amended Article is given in a separate item in this issue.

By-Laws Revised re "Student Chapters"

After due notice as regularly required, and upon recommendation by its Committee on Student Chapters, the Board amended the By-Laws, "Article V. Student Chapters," as to Sections 4 and 6. Text of revised sections is given in a separate item in Society Affairs.

Meeting Recommendations for 1944

The Board constituted the four Vice-Presidents a committee to report to the Board at its October meeting on recommendations as to 1944 meeting place.

Washington Report

Confidentially, the Society's representative in Washington, D.C., Hal H. Hale, reported to the Board on many matters relating to prospective federal legislation and departmental policies as they may affect civil engineers.

Collective Bargaining for Engineers

The Board gave extended consideration to the report by H. F. Peckworth, Assistant to the Secretary, concerning the effort of the professional engineers to obtain recognition as a collective bargaining agency separately from a union of sub-professional employees at the Sunflower Ordnance Plant. (See page 337 of the July issue and page 394 of the August issue.) On another page appears a summary of the Board's attitude toward this vital question.

Postwar Work

With only minor changes, the Board adopted the report of the newly appointed Committee on Postwar Construction, outlining the practicabilities of postwar construction in alleviating unemployment, and stressing the need for the present planning of economically sound, needed, and useful public works. (See leading item in Society Affairs, this issue, for full report.)

A supplementary report outlined procedures whereby an adequate program may be made operative. This the Board adopted, making available to the Committee a suitable appropriation.

New Manual on Collective Bargaining

Approval was given to the issuing of a new manual on "The Engineer and Collective Bargaining," as formulated by Mr. Peckworth. The necessary appropriation was made for printing and distribution in limited quantity to Society officers and Local Sections, also to interested members.

Other Committees

Reports of progress or of information for the Board were received from numerous committees, resulting mostly in routine action.

Miscellaneous

A number of other matters pertaining to Society administration, professional matters, and other items were considered, with appropriate action in each case.

Adjournment

Upon completion of its agenda late Friday afternoon, July 30, the Board adjourned to meet with the Georgia Section of the Society during the week beginning October 10, at the Atlanta Biltmore, Atlanta, Ga.

Board Action on Collective Bargaining

A BASIC question affecting all engineers has arisen in connection with a controversy over the appropriate unit for bargaining purposes among engineering employees at the Sunflower Ordnance Works at Eudora, Kans., as previously mentioned in the July and August numbers. The important principle involved is whether professional engineers can be represented in labor matters by a group of their own, or whether they must be included in a sub-professional group which might then dominate the whole activity. This entire question was considered in detail and at length by the Board at its recent meeting in Los Angeles. A few of the Board's opinions may be mentioned briefly.

No opposition to unions per se was expressed. The Board, however, did find objection in the possibility that professional engineers might be forced to join with sub-professional groups of employees, wherein they would be outnumbered perhaps three or four to one. The unfairness of such a condition and its possibilities for injury to the profession were deemed to be obvious.

In addition, the Board studied a definition of the term, "professional engineer," such as might be considered satisfactory by the War Labor Board. The purpose of such definition would be to identify a minority group of engineers, technically trained and professionally minded, and differentiating it from technicians and other workers in the same engineering field. The outcome of this particular consideration was to refer the subject to the Society's Committee on Employment Conditions.

Finally, the Board came to a firm understanding that vigorous efforts are to be made to explore the various federal enactments and to secure the practical formation of groups comprising professional engineers exclusively. The purpose of such groups would be to bargain collectively, separately from any bodies of sub-professional employees that may be formed. The Board further implemented its action by making an appropriation to carry the project forward.

Society Invited to Georgia Section Meeting in October

SINCE there will be no Fall Meeting of the Society this year, the Georgia Section is offering its facilities with characteristic Southern hospitality. It invites all members wherever they live to attend its Fall Meeting in Atlanta next month. The dates will be October 13 and 14, and the Atlanta Biltmore Hotel has been selected as headquarters of the meeting. Although this is to be a meeting of the Georgia Section, it will have some of the features of a regular Society gathering. That is, the Board of Direction will be present for its usual October meeting, and there will be a Local Sections Conference. The technical program, however, and whatever social features may be arranged are under sponsorship of the Atlanta members.

A very cordial welcome and enjoyable visit await all those who can possibly arrange to attend the meeting in Atlanta. Though no elaborate plans are being made because of the current war conditions, the members of the Georgia Section promise to make every one's visit worthwhile.

Full details of the program are not available as we go to press with this issue, but a complete outline of events has been promised for the October number. However, the following schedule will be generally adhered to in planning details of arrangements:

Sunday,	October	10—Meetings of Committees of Board of Direction
Monday,	October	11—Meeting of Board of Direction
Tuesday,	October	12—Local Sections Conference Meeting of Board of Direction
Wednesday,	October	13—Registration and Opening Session of Georgia Section Meeting Technical Meeting of Georgia Section Dinner and Entertainment
Thursday,	October	14—Technical Meeting in Morning Inspection Trip in Afternoon

Though not mentioned in the foregoing general outline, several enjoyable events are being planned for the ladies, including a trip to Atlanta's far-famed Cyclorama.

The Georgia Section particularly urges members of neighboring Local Sections to come to Atlanta in October. It hopes they may avail themselves of the opportunity to enjoy a good technical program, and to meet and become acquainted with all the Society officers and Directors who will be present.

John Watson Alvord, Honorary Member, Dies

WITH the death of John Watson Alvord, retired Chicago consultant and Honorary Member, the Society loses another of its distinguished members. Mr. Alvord died at his summer home at Douglas, Mich., on July 31, at the age of 82. For more than thirty years he headed the engineering firm of Alvord, Burdick and Howson.

Born in Boston, Mass., on January 25, 1861, he was brought up and educated in Washington, D.C. At the age of 17 he entered the employ of the Denver Pacific Railway and worked as a passenger-train brakeman, running out of Cheyenne when it was a Wild West mining town. In 1879 he went to Chicago, where he served as assistant engineer in charge of construction on the Hyde Park and Lake View water works systems, from 1880 to 1884; city engineer of Lake View (now a part of Chicago), 1884 to 1888; and town engineer for Cicero, Ill. In 1889 he became chief engineer of surveys for the World's Columbian Exposition at Chicago, and for the ensuing four years headed a large engineering organization that coordinated the extensive building operations connected with that undertaking.

JOHN WATSON ALVORD

In 1894 Mr. Alvord entered private practice as a consulting engineer with headquarters in Chicago, and, in cooperation with his partners, served about 300 municipalities in various parts of the country on problems of public water supply and sewerage. He was particularly concerned with the finances of water supply and the valuation of water-works properties and was frequently employed as a member of appraisal boards in matters of valuation. From 1918 until shortly before his death he was a member of the State (Illinois) Board of Natural Resources and Conservation.

During the first World War Mr. Alvord was supervising engineer at Camp Grant, Ill., and from 1917 to 1919 he was also chief engineer of the U.S. Housing Corporation.

A member of numerous engineering and scientific societies, in 1916 he founded and endowed the Washington Award (in honor of George Washington, one of the earliest engineers). This award is conferred each year on some engineer for preeminent services in promoting public welfare. Mr. Alvord was elected a member of the Society in 1893, and Honorary Member in 1935. He also served as Director of the Society in 1917 and 1918 and, again, for the term, 1919 to 1921.

Wartime Convention in Los Angeles

Program Attuned to National Emergency Serves Large and Successful Meeting, July 27–31

WHATEVER misgivings were raised by the thought of trying to hold a Society Convention in the summer of 1943 were dispelled by the successful and enthusiastic outcome of the sessions at Los Angeles. Admittedly, the handicaps were great and no one could predict in advance whether the result would be satisfactory or regrettable. Fortunately, the meeting outdid all expectations and was a pleasant surprise to even the most optimistic proponents.

SCHEDULE IN OUTLINE

As planned, the meeting started on Tuesday, July 27, with an all-day gathering of Local Section representatives. On Wednesday morning, the Convention session was held, while the remaining two and one-half days were devoted exclusively to meetings of the Technical Divisions. Finally, on Saturday, a series of inspection trips was scheduled. Committee and Board meetings were also held during the same period, commencing Tuesday. The Biltmore Hotel, as headquarters, accommodated practically all the events.

The first pleasant surprise was in the attendance. It was realized that this would be largely local in character because of wartime travel regulations. With this handicap, it was hardly to be expected that some 725 persons would surmount the difficulties of attendance. Similarly wide interest was also shown in all events both technical and social.

START IS AUSPICIOUS

Formalities were entirely confined to the Wednesday morning session, which was opened by Julian Hinds, president of the Los Angeles Section. The spirit of the meeting was emphasized by brief ceremonies conducted by a color guard of one of the local engineering regiments. This included calls by the Bugle Corps, presentation of the colors, prayer by the Chaplain, and singing of "The Star Spangled Banner," all conducted with military precision.

After the troops had retired, the chairman introduced Mayor Bowron, who welcomed the Convention to Los Angeles. President Whitman responded briefly, after which he complied with the Constitutional provision requiring that he give an Annual Address. In this he reviewed the wartime activities and progress of the Society. The other main address of this general meeting was delivered by Maj. Gen. Eugene Reybold, M. Am. Soc. C.E., Chief of Engineers. The latter's talk was also in the nature of a review, covering the various activities of the Army Engineers at home and abroad. The President's Address will appear in full in the forthcoming 1943 TRANSACTIONS, while General Reybold's is given in somewhat condensed form as the leading article of this issue (page 401).

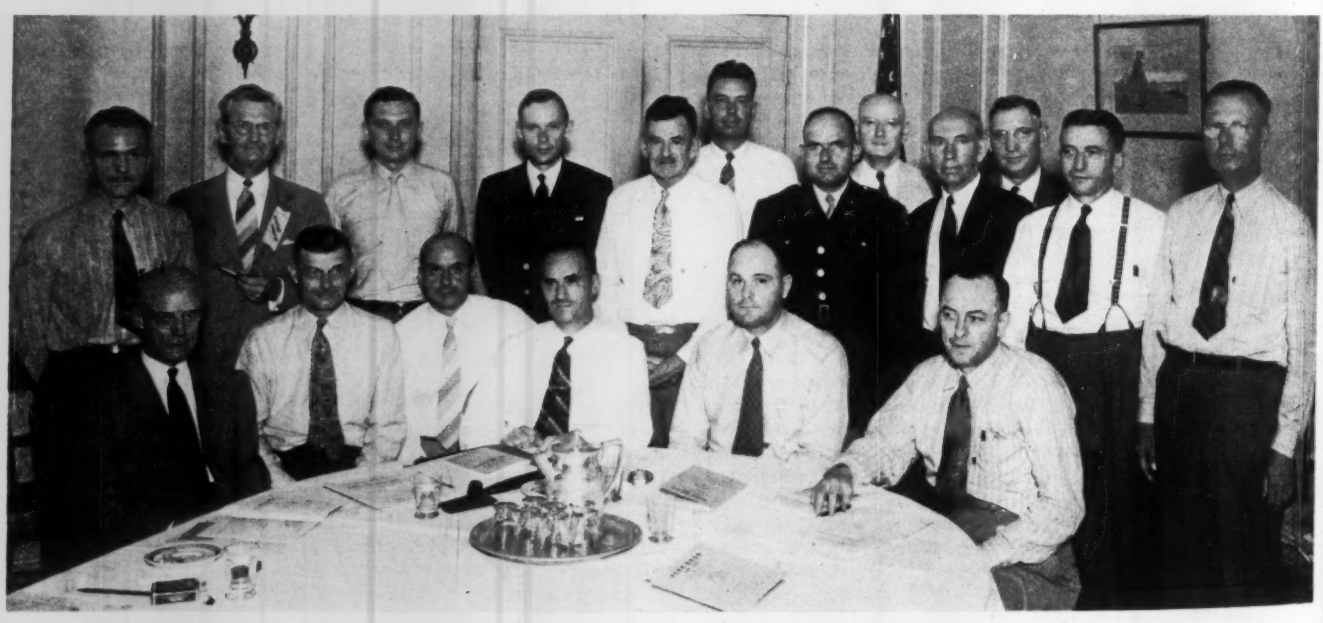
Immediately following these ceremonies, a large luncheon was held in an adjoining room. This was the first opportunity for social contacts and was much enjoyed by both men and women. At the conclusion, a brief informal program, consisting of impromptu talks on the general subject of postwar planning, was presented by three members. Those participating were Past-Presidents F. H. Fowler and E. B. Black, and Samuel B. Morris, president of the American Water Works Association.

MEETINGS AND DINNERS INTERSPERSED

Technical Divisions monopolized the afternoon session as well as the following two days of Thursday and Friday. No attempt will be made here to detail these meetings. Suffice it to say that the sessions were helpful in the extreme and were enthusiastically received. All were keyed to the national interest in the war effort. It is hoped that many of the papers presented will appear later in PROCEEDINGS OF CIVIL ENGINEERING.

Interspersed with this fine technical program, a number of informal social gatherings were enjoyed. On Wednesday evening the traditional dinner and dance took place. After a fine dinner, there were brief introductions of Society and Local Section officials and guests. The main feature was an address by Leo Carillo, noted personage not only in the movie industry but in his native Southern California. Mr. Carillo gave a most interesting account of the historic Spanish background of the vicinity. Incidentally, he mentioned his own indebtedness to the engineering profession, with which he made his early start in heavy construction work.

The following day, Thursday, a special luncheon had been scheduled, which proved to be the most popular in point of attendance during the Convention. It was arranged by cooperation of the



LOCAL SECTIONS CONFERENCE GROUP AT LOS ANGELES CONVENTION

Sitting (Left to Right): C. T. Leeds, of Los Angeles; E. H. Collins, of Spokane; L. F. Raeder, of Boulder, Calif.; E. M. Knapik, of San Francisco; L. O. Fiscel, of Florence, Ariz.; and S. W. Holcomb, of Corvallis, Ore. Standing (Left to Right): R. R. Rowe, of Sacramento; A. F. Barnard, of Los Angeles; T. R. Dames, of Los Angeles; O. C. Reedy, U.S. Navy; Lothrop Crosby, of Tacoma; M. E. Salsbury, of Los Angeles; F. H. Rhodes, U.S. Army; Franklin Thomas, of Pasadena; Sydney Wilmot, of New York City; C. E. Mockmore, of Corvallis, Ore.; M. T. Wilson, of Salt Lake City; and W. C. Brown, of San Diego

LARGE GROUP OF MEMBERS AND GUESTS VISITS THE FONTANA STEEL PLANT ON SATURDAY, JULY 31

Society and the Associated Genera Contractors, especially to hear General Reybold. Both President Coblentz and Managing Director Foreman, of the Associated General Contractors, were in attendance. The largest ballroom of the hotel was required. In effect, General Reybold's address was an eloquent appeal to engineers and contractors to assist the Army in the expansion of its construction battalions for large-scale operations, including important projects overseas. As in the case of his previous day's address, this appeal was received with understanding and enthusiasm.

LADIES ALSO ENTERTAINED

The ladies were not invited to this luncheon. Instead, they had their own luncheon at the nearby University Club, followed by an interesting program featuring Lloyd C. Douglas, author of the currently popular, *The Robe*, which was given to visiting ladies as favors. That same evening the ladies enjoyed a performance of the stage success, *Claudia*.

Another popular event for men only was scheduled for Thursday evening. This likewise was at the University Club in the room generally used for Los Angeles Section meetings. Again a fine meal was enjoyed. Later there was a program of entertainment with music, a sleight-of-hand artist, ably assisted by a number of dignified Society members, and a witty speech by Right-of-Way Engineer Balfour, of the State Highway Department.

Informal entertainment was also provided for the last day of the technical meetings. On Friday the ladies enjoyed a luncheon and fashion show at one of the large department stores, while the men lunched together at the headquarters hotel. This luncheon was in the nature of a farewell get-together.

With the sessions of the Technical Divisions on Friday afternoon, the technical part of the meeting was completed. On the Saturday morning following, a number of inspection trips were available. These were arranged so as not to interfere with the meetings themselves, which were considered the prime objective of the Convention. Arrangements for the trips included opportunities for visiting the tremendous new steel mill at Fontana, Calif.; the 100-mgd softening plant of the Metropolitan Water District at La Verne, Calif.; and a shipyard in the city's harbor district. Unfortunately, many of the out-of-town visitors had to leave prior to these interesting trips. An account of the post-convention tour by Society officers starting Friday evening is given in another item.

Incident to the Los Angeles Meeting, but unofficial, was a most enjoyable dinner given on Tuesday evening by members and officers of the Local Section to Board members and their wives. This was held in the picturesque surroundings of the Spanish Quarter at Casa La Golondrina. Cordiality and informality were the order of the evening. This happy mood was heightened by the atmosphere of Spanish music, dances, and entertainment.

Contemporaneous with the technical sessions, the Board of Direction held its meetings. There were five separate sessions of each but, if anything, the Board meetings were the longer. In addition, the Board committees met as they could sandwich in the necessary time, starting Tuesday noon; and numerous breakfast and luncheon sessions also had to be arranged. All in all, it was a busy and fruitful session of the Board, as indicated in more detail in items elsewhere in this issue.

LOCAL SECTIONS CONVENE

As a concrete part of the Convention, a full-day Local Sections conference was held on Tuesday, July 27. Under the chairmanship of Capt. Fred H. Rhodes, of the Society's Committee on Local Sections, representatives from 10 Western Sections gathered for mutual discussion and helpful exchange of experiences. A number of these attending are shown in an accompanying photograph. On the agenda were the following topics:

- Employer-Employee Relationships
- Engineers' Part in Postwar Planning
- Encouragement of Participation in Local Section Activities and Collection of Local Section Dues
- Effect of War on Local Section and Student Chapter Activities
- Junior Forums—Their Programs and Relationship to Local Sections
- Engineer's Part in Public Life

In addition, both the President and the Secretary of the Society gave brief talks. From time to time during the day this meeting was the magnet for a number of Board and local members who enjoyed the thoughtful discussions.

NOTABLE WARTIME DIFFERENCES

Summing up the Los Angeles Convention, it may be said that it maintained the high standard of Society meetings. Though it resembled the ordinary meeting in many ways, it also had its points of difference. Analysis of the attendance emphasizes a change of meeting habits that had been anticipated—that is, the group, although unusually large, was mostly local, and the number attending from any distance, barring Board members, was almost negligible. Furthermore, the absence of Student Chapter and other young members was marked. Another difference was in the social events, which were entirely informal—an innovation which appealed particularly to those coming from a distance. Again, it was a surprise to find that accommodations were insufficient for the demand. This applied not only to many of the Technical Divisions, where the hotel rooms were so crowded that dozens sat outside the doors, but also to the social events, for which in almost all cases wartime provisions were completely exhausted. Many found to their sorrow that failure to make reservations meant eventual failure to secure tickets at the last moment.

Still another innovation was in postponing the inspection trips until the technical sessions were completed. Perhaps this did react to the detriment of the trips, but it certainly provided the proper incentive to the meetings, which were active and enthusiastic to the very end. A number of Division meetings had to exchange quarters to secure larger accommodations. And finally, the Los Angeles Convention was unique in that every one of the 12 Technical Divisions held sessions. This is a record, but its significance is

in the vision of the Division officers and in the fact that their ideals were justified by the results.

Local arrangements were capably handled by the committee under A. L. Gram, general chairman. Assisting him and President Hinds were the following heads of subcommittees: Wallace L. Chadwick, Trent R. Dames, William A. Dunning, Ernest E. East, Sterling S. Green, Mrs. Sterling S. Green, William W. Hurlbut, Roy L. Anderson, Charles T. Leeds, John F. Skinner, and L. J. Alexander. Theirs should be the satisfaction of a splendid job, fully appreciated by a large and enthusiastic attendance.

By-Laws Amended as to Article VIII, Re Technical Divisions

By unanimous action of the Board at its Los Angeles Meeting, provisions in the By-Laws for operating and administering Technical Divisions rather than "Technical and Functional Divisions" as previously designated (see pages 47 and 48 of current Yearbook) were entirely changed. Since each of the paragraphs is amended or renumbered, it is necessary to quote the entire amended Article VIII, as follows:

ARTICLE VIII. TECHNICAL DIVISIONS

1. A Technical Division of the American Society of Civil Engineers may, by the action of the Board of Direction, be organized for the consideration of any engineering or scientific subject, provided that not less than 50 Corporate Members of the Society unite in making written request for such an organization, defining its scope. Such a Division shall be designated as . . . Division of the American Society of Civil Engineers. (The blank shall be filled by the title of the subject specialized.)

The organization of a Division shall become effective upon approval by the Board of Direction of the request for organization of such Division.

2. The objective of each Division shall be to advance the science and art of engineering in that special field or branch indicated by the name of the Division.

3. Members of the Society, in any grade, may become members of a Division or Divisions, by enrollment, and shall not be subject to payment of any dues other than the regular dues of the Society.

4. Under the administrative authority of the Board of Direction, charge of the affairs of each Division shall be vested in an Executive Committee of five Division members who are Corporate Members of the Society, each to hold office for five years, with one member retiring annually at the close of the Annual Meeting in January, at which time the newly appointed member shall take office. When a new Division is authorized, the Board of Direction shall appoint the first Executive Committee, including its Chairman, and fix the term of office of each member of the Executive Committee.

Not later than October 1 of each year, each Executive Committee shall forward to the Board of Direction the names of not less than 3 nominees, in order of preference, from which the Board shall appoint one as the new member of the Executive Committee. No member of the Executive Committee who has served more than one year shall be appointed so as to succeed himself immediately. Should a vacancy occur in the Executive Committee prior to the expiration of the term of any member, the vacancy shall be filled for the unexpired term by the Board of Direction in the manner prescribed for the appointment of a new member. Meetings of the Executive Committee shall be held at the call of the Chairman or of any three members of the Committee. A quorum of the Executive Committee shall consist of three members. Questions may be decided by letter ballot of the entire membership of the Committee.

New committees of a Division shall be established by its Executive Committee with the approval of the Committee on Division Activities. Membership on committees of a Division may be altered at will by its Executive Committee.

5. The Executive Committee shall elect one of its members as its Chairman, and he shall be Chairman of the Division. The Executive Committee may elect a Secretary from among the Division members. The Chairman, or in his absence the senior member present, shall preside at all meetings of the Executive Committee. The Chairman, or his designated alternate, shall preside at all sessions of the Division. The Division Secretary, or Chairman, shall keep a record of all meetings of the Executive Committee and of all actions taken. A copy of such record shall be transmitted promptly to the Secretary of the Society.

6. Sessions of the Division shall be held in connection with the regular meetings of the Society and the programs of such sessions shall be arranged by its Executive Committee.

Neither at a session of the Division nor at a meeting of the Executive Committee shall an action be taken which will be deemed to be expressive of an attitude or action by the Society, but resolutions or recommendations may be addressed to the Board of Direction of the Society for consideration, or approval and promulgation.

7. The Division shall incur no financial obligations chargeable to the Society unless such are specifically authorized by the Board of Direction and provided for in its approved budget. No liability incurred other than as above provided shall be binding on the Society.

8. The Board of Direction of the Society may, upon recommendation of the Committee on Division Activities, suspend or disband any Division on 60 days' notice or may at any time remove from office any member of the Executive Committee of the Division.

Revision of By-laws, Article V, Re Student Chapters

FORMAL ACTION was taken by the Board of Direction in Los Angeles amending Sections 4 and 6 of "Article V. Student Chapters" of the By-Laws. The new provisions affect details only, changing dates for the annual Chapter report, and annual dues, as noted in the following paragraphs.

Section 4 now provides for an annual report of each Student Chapter not later than June 15, covering activities during the academic year. This is now amended to read as follows:

"4. Each Student Chapter shall submit an annual report, not later than February 1st of each year, which shall include:

(*a*) A summary statement of the meetings held during the calendar year; giving the date of each, the attendance, the principal speaker and his subject, and other pertinent information."

Similarly, Section 6 has provided that dues payable October 1 apply for the year beginning July 1, with reduction to Chapters admitted after January 1. This section is now amended to read:

"6. The annual dues shall apply to the year beginning January 1, and shall be due on the preceding December 1. Student Chapters admitted on or after April 1 of each year shall pay only $5 for the remainder of the current year to January 1."

Papers Filed in Engineering Societies Library

TRUSS STRESSES AND DEFLECTIONS

C. K. WANG, "Determination of Truss Deflections and Indeterminate Stresses by Joint Displacements" (24 pages of text and diagrams). A method of computing the movements of all joints of a truss due to changes in length of members is given. There is also an algebraic solution of the Williot-Mohr diagram.

THEORETICAL ANALYSIS—REINFORCED CONCRETE

M. HILAL, "Stresses in Reinforced Concrete Sections Subject to Eccentric Forces and Double Bending" (38 pages of text and diagrams). Analytical methods developed in German texts not readily available to the American reader are presented.

STRUCTURAL ANALYSIS—INDETERMINATE FRAMES

ALEXIS MINORSKI, "Locus of Summation of All Stresses Giving Solution of Indeterminate Systems" (23 pages of text, tables, curves, and diagrams). A convenient graphical short-cut to the solution of certain problems of special loading is given.

CAVITATION BIBLIOGRAPHY

ALFRED M. FEILER, "Cavitation Bibliography" (47 pages). This comprehensive bibliography covers fluid mechanics, cavitation corrosion, ship propulsion, turbines, pumps, and wind tunnels.

Modern Society Circuit Riders

Post-Convention Tour Visits Four West Coast Sections, Bringing National Officers and Their Messages to Local Members

TO MANY members of the Board, the Los Angeles Meeting at the end of July was simply the forerunner of other delightful contacts with loyal Society members in the Pacific states. Most of the following week was taken up with a series of visits, brief and informal in character, extending up into northern California, into Oregon, into western and then eastern Washington. From the standpoint of both the Society officers concerned and the Local Sections entertaining them, this type of "grand tour" was a great success.

The idea had its genesis in the original plans of the Los Angeles Convention. When the entire western field was canvassed, it was found that there was great demand for visits or even to entertain the Convention itself, on the part of the various Sections. Since only one could entertain the main meeting, it was suggested that some of the Society officers might well arrange to visit the remaining Sections on their way to or from Los Angeles. Out of this grew the detailed plans for the post-Convention tour.

AN EARLY START TO SAN FRANCISCO

As finally worked out, the trip started Friday evening, July 30, immediately after the conclusion of the technical sessions of the meeting at Los Angeles. That this was before the inspection trips on Saturday was regrettable but unavoidable. A surprisingly large number of officers and Directors, from both the east and the west, took part. On the overnight trip to San Francisco, there were 35; gradually this number tapered off as busy men had to leave for home but even at Spokane, the last stop, there were 15 in all in the party.

The schedules went through without a hitch. In general, the traveling was comfortable but that was secondary. The main purpose of the trip was the contacts, and these were all that could be desired.

After an overnight ride the first stop was at the Hotel St. Francis in San Francisco. Arriving early Saturday morning, the party spent the forenoon in shopping or other business. After luncheon local members provided a fine tour of scenic and historic spots, ending at the Engineers' Club, where a cocktail party had been arranged. Restrictions in the Saturday afternoon club service prevented anything more elaborate. However, there was a brief meeting at which local members listened to President Whitman, Secretary Seabury, Vice-President Stanton, and Director Scobey.

ONE GROUP ENJOYS SHASTA DAM

At this point in the schedule there was a division of plans. Most of the party availed itself of the opportunity to take an early train on Sunday, stopping off at Redding, Calif., to visit Shasta Dam. The remainder took an afternoon train, which the Redding party joined at night, continuing together to Portland. Accommodations on the earlier train were not all that could be desired, but the end of the trip was well worth any discomfort. Arriving at Redding in the late afternoon, the party was met by a number of automobiles manned by officials of the U.S. Bureau of Reclamation and Pacific Constructors, Inc., builders of Shasta and Keswick dams. The delegation and the hosts proceeded immediately toward Shasta Dam, stopping on the way at Keswick Dam, a few miles lower down on the Sacramento River. An interesting view was had of this important job from below (as shown in one of the photographs), but no effort was made to cover it in detail. Instead, the party proceeded shortly on to the larger Shasta project which was the main objective.

Following a short stop on the side of the canyon near the dam for a general view, some instinct led the group directly to the mess hall. There the treat of steak dinner had been provided by courtesy of the contractors. As night was coming, no extended meal was feasible, but instead the caravan proceeded quickly to the further side of the river, up the cliff to the finished west abutment. There the giant 460-ft steel tower and its attached cableways were of much interest, as concrete production and placing was progressing even on a Sunday evening. The concrete itself was found to be largely in place, and only the upper half of the central sections remained unfinished. The next stop was at the power house, where the group stayed long enough to note the progress in erecting a number of the generators, and incidentally to view the discharge of 5,000 cu ft per sec from the by-pass tunnel.

Time still remained for one last thrill—to visit the celebrated Pit River Bridge—several miles to the northeast. As the sun was going down, the party reached this tremendous structure, then drove into the canyon to inspect it from 500 ft below. The party then repaired to Redding in time to catch the train at 10:45 p.m.

PORTLAND AND ITS SHIPYARDS

Arrival of the recombined party at Portland occurred at 1 p.m. on Monday, August 2, with registration at the Hotel Multnomah. Arrangements for the afternoon included a drive around the city. Then in the evening members of the Portland Section, with visitors from Tacoma and nearby places, entertained the group at dinner. The President and a number of Directors gave brief addresses following the meal. Then most of the visitors enjoyed an evening reception at the home of Director Cunningham, whose home afforded a splendid night view of the city and the Willamette Valley.

A treat was in store the following morning. For the ladies it was

KESWICK DAM, SACRAMENTO RIVER NEAR REDDING, CALIF., IS INSPECTED BY PARTY OF SOCIETY MEMBERS, SUNDAY, AUG. 1

GROUP OUTSIDE MULTNOMAH HOTEL, PORTLAND, ABOUT TO START VISIT TO SWAN ISLAND SHIPYARDS

Clearly Visible, Left to Right, Are: Dean G. Edwards, New York, N.Y.; Hal H. Hale, Washington, D.C.; R. B. Wiley, Purdue University; E. E. Howard, Kansas City, Mo.; G. J. Requardt, Baltimore, Md.; W. D. Dickinson, Little Rock, Ark.; F. H. Fowler, Washington, D.C.; C. M. Spofford, Boston, Mass.; E. B. Whitman, Baltimore, Md.; J. C. Stevens, Portland, Ore.; G. T. Seabury, New York, N.Y.; E. B. Black, Kansas City, Mo.; C. E. Green, Portland, Ore.; J. W. Cunningham, Portland, Ore.

again a ride around the city, but for the men the trip was to the Swan Island Shipyard of the Kaiser Company. It was thus possible to follow the process from the receipt of materials, to their fabrication, then subassembly, and finally, full assembly on the launching ways. The ships themselves—large tankers—were in various stages of completion. The last visit was to the outfitting dock for an inspection of one of the vessels which was practically ready for commissioning. No photographing of the shipyard was permissible, but a view of the party as it started from the hotel is included here.

A pleasant rail trip to Seattle occupied the afternoon. After registering at the Olympic Hotel the visitors were invited immediately to a dinner meeting of the Seattle Section at the Benjamin Franklin Hotel. The dinner was excellent and was followed by illuminating talks by the President and the Secretary. This was President Whitman's last official appearance as he had to leave immediately for the east.

SEATTLE DELIGHTS VISITORS

The following day, August 4, was occupied almost exclusively with sightseeing, by courtesy of local Society members. In the morning an auto trip took a group to visit the unique two-mile floating bridge over Lake Washington on the eastern edge of the city. This fascinating structure was inspected in full, including the traffic-control features, the operating devices for the draw span, and even the interior cells of the floating concrete sections. Fortunately, C. E. Andrew, engineer for the structure, was present to explain the details. Especially interesting was the demonstration of the operation of the floating draw span, as it was pulled back longitudinally into the U-shaped floating abutment. Another interesting feature was the supporting connections between the floating part and the steel arch spans at the end, which connections were designed to accommodate motion in three planes.

Returning to headquarters by way of the University of Washington, the party halted briefly to visit the laboratory and wind tunnel where the Tacoma Bridge research is being conducted. A view of the model under construction and of movies of previous tests were most instructive.

In the afternoon the ladies were entertained by an auto ride and tea while the men had a separate and unusual treat. By courtesy of the Coast Guard a splendid motor yacht was made available for an extended water tour—first, in Seattle Harbor. In turn, succeeding views showed the extensive docks and shipping operations, large shipyards and outfitting piers for naval vessels, shore and marine installations for military use, and numberless other features of a great port.

Proceeding to the Lake Washington Ship Canal, the vessel was locked up and into the waterway, through the ship canal to Lake Union, and thus into Lake Washington, a large and picturesque body of fresh water, extending for 20 miles along the eastern edge of the city. Beautiful residences, an airfield, and more shipyards were on view on this lake tour. Finally, another trip along the entire length of the floating bridge, this time from the water side, completed the 40-mile sail. Delightful weather made the trip exhilarating and memorable in the extreme. Return from the landing dock was by trolley bus.

IN AND AROUND SPOKANE

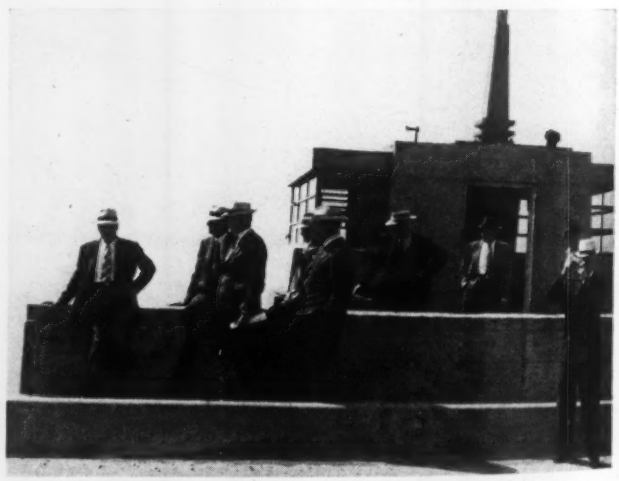
Again an overnight ride, and this brought the party on Thursday morning, August 5, to the last stopping point, Spokane. There comfortable quarters were found at the Davenport Hotel. While the ladies were attending a piano recital and luncheon, the men were entertained at a luncheon in the hotel. At its conclusion, a few presentations were made, but the main program included brief talks on problems of postwar construction. Various members of the Board, including Past-Presidents Black and Fowler, Vice-President Stanton, Directors Edwards, Dickinson, and Wiley made comments. This luncheon concluded Past-President Black's part of the tour as he and his family left shortly afterward.

Separate drives for the ladies and men occupied the afternoon. One was purely scenic and the other was to engineering points of interest. The latter included features of the Spokane Water works—the elevated water tower, the Ray Street pumping station, and the municipal power plant and pumping station on the Spokane River. There was a stop at the naval stores depot a few miles from the city, and return by way of the great aluminum plants which constitute one of Spokane's newer industries.

ONE LAST DINNER

As a final event of the tour, the Spokane members and their wives joined the entire official party at dinner in the headquarters hotel. After brief talks, both Past-President Fowler and Vice-President Stanton had to leave to catch trains. Secretary Seabury then called attention to a number of interesting features of current Society work, and his talk was followed by comments from Messrs. Edwards, Dickinson, and Wiley.

This dinner really concluded the official visits. However, the following day a small party in a single car was taken for a most interesting inspection trip of Coulee Dam, 90 miles to the west. The return east from San Francisco, Portland, Seattle, and Spokane was by various routes—some in the United States, some in Canada. The following participated in one or more—usually most—of the stopovers: Admiral and Mrs. R. E. Bakenhus; Mr. and Mrs. E. B. Black, also Patricia and John Black; Prof. and Mrs. C. B. Breed; Col. W. N. Carey; Mr. and Mrs. J. W. Cunningham; W. D. Dickinson; Mr. and Mrs. Dean G. Edwards; Mr. and Mrs.



INSPECTION OF FLOATING BRIDGE OVER LAKE WASHINGTON SEATTLE

Draw, in Foreground, Has Been Retracted (Floated) Into Slip to Open Bridge. Operator's House Is on Fixed, Although Floating, End

PART OF SOCIETY INSPECTION GROUP AT RAY STREET PUMPING STATION, SPOKANE WATER WORKS

F. H. Fowler; Mr. and Mrs. C. F. Goodrich; Hal H. Hale; Mr. and Mrs. E. E. Howard; G. B. Massey; Mr. and Mrs. L. E. Peterson; G. J. Requardt; F. C. Scobey; George T. Seabury; Prof. and Mrs. C. M. Spofford; Mr. and Mrs. T. E. Stanton; President Ezra B. Whitman; Prof. R. B. Wiley; and Mr. and Mrs. Sydney Wilmot.

Tellers Report on First Ballot for Official Nominees

To the Secretary *August 2, 1943*
American Society of Civil Engineers

The tellers appointed to canvass the First Ballot for Official Nominees report as follows:

For Vice-President, Zone I

Richard E. Dougherty	211
A. W. Harrington	74
Scattering	130
Void	62
Blank	4
Total	481

For Vice-President, Zone IV

Franklin Thomas	327
F. C. Scobey	49
J. T. L. McNew	34
Scattering	199
Void	28
Blank	5
Total	642

For Director, District 3

S. C. Hollister	34
R. G. Finch	12
Scattering	10
Void	15
Blank	1
Total	72

For Director, District 5

Gail A. Hathaway	185
Scattering	16
Void	31
Blank	1
Total	233

For Director, District 7

Leroy C. Smith	104
Raleigh W. Gamble	71
Scattering	2
Void	15
Blank	0
Total	192

For Director, District 8

Wilbur M. Wilson	88
Scattering	28
Void	26
Blank	0
Total	142

For Director, District 9

Frank C. Tolles	100
Daniel V. Terrell	37
Scattering	13
Void	16
Blank	0
Total	166

For Director, District 12

W. D. Shannon	89
R. G. Tyler	36
Scattering	7
Void	10
Blank	0
Total	142

For Director, District 16

Royce J. Tipton	101
Charles H. Scholer	76
Scattering	7
Void	14
Blank	0
Total	198

Ballots canvassed		2,268
Ballots withheld from canvass		
From members in arrears of dues	67	
Without signature	11	
Illegible signature	1	79
Total number of ballots received		2,347

Respectfully submitted,
JAMES McB. WEBSTER, *Chairman*

Joseph Farhi	Theodore P. Kilian	Leonard Capling
Harry W. Stuber	George L. Freeman	Alfred M. Wyman
Arthur S. Pearson	George C. Maguire	Louis Goodman
Byron O. McCoy	William H. Mueser	Solomon B. Arison
William H. Dieck	Albert P. Loriot	Frank L. Greenfield
R. F. Schaefer	Harry Newman	

Tellers

City Engineering as a War Casualty

MEN in the armed services are receiving generous credit for accomplishment in the war—none more than the engineers, and rightly so. But there is another phase of service that is apt to be overlooked or perhaps receive scant credit. It is the everyday persistence of those who are carrying on in civilian life against great odds, to make the more spectacular activities of our fighters possible.

One such person, a city official, has written to Society Headquarters to explain why he finds it impossible to submit written comments upon a sanitary engineering article. He discloses that: "The war has reduced the number of employees in my department by 52½%. Wages paid elsewhere, the desire to join the military forces, and also the establishment recently of a pension plan have been the main causes for these reductions. All we have left are the 'lame, the halt, and the blind,' 'grandfathers,' and children.

"I would like to have you supply me with some substance that would remove the sludge or slime that keeps salaries and wages of municipal employees at such a low level."

Modifications of CIVIL ENGINEERING Format

MANY members may have noticed the change of size in CIVIL ENGINEERING, commencing with the July issue; or perhaps the striking colored cover emphasizing the American flag distracted their attention from this basic change!

In the main, the modification has to do with the trim size or over-all dimension, as previously announced. The former outside measurements were $11^3/_4 \times 8^3/_4$ in., and the new ones are $11^1/_4 \times 8^1/_8$ in. In making the changes, the type page itself has not been altered. Of course, it has been moved somewhat to keep it in general centered on each sheet. If one looks carefully, he will note that the margins look somewhat skimpy, at least by comparison with the previous size. But in this particular the result is not too distasteful—at least no comment in criticism of the new format has been received.

Another change in printing procedure is involved in the binding. The Government permits only a single wire staple to hold all the printed forms together. In addition there is the glue which also acts to stiffen the magazine at its binding edge. By the way, the same condition holds for PROCEEDINGS. If anything, the single staples permit the pages to open somewhat wider than otherwise, and this is an advantage in view of the decreased margins. Otherwise, the binding does not appear so workmanlike and the pages tend to wrinkle near the single staple upon opening. But in this instance, as in the paper reduction, the effect is not serious.

Thus in two respects—economy in the use of metal wire and paper tonnage—the Society is cooperating with the Government. Further paper cuts, if imposed, will probably not become effective until the fall. Meanwhile readers of Society publications may feel that they are making some sacrifice toward the attainment of our common national goal.

CIVIL ENGINEERING in Army Camps

LETTERS addressed to Headquarters from men in military service have indicated great interest in Society publications. Now comes a development which reaffirms, or perhaps results directly from, this popularity.

Since March 1, about 250 subscriptions of similar character have been received for CIVIL ENGINEERING. These have come from Army post engineers or from others in authority. They have had no special geographical pattern as camps located throughout the country are represented. Some were from internment camps, others from arsenals, airfields, and training centers. Of course a great many came from regular Army camps.

It has always been a fair inference that this publication is well liked by service men. Doubtless articles on the military effort or on features connected with war activities explain the popularity in part. Also, it is believed that the usual articles and the professional features, which attempt to present in a pleasing way interesting or basic developments in the field of engineering, have proved an attraction.

This latest evidence of interest provides added inspiration in the effort to provide the best that the profession has to offer. Continued cooperation of members and Local Sections in maintaining the high standard of CIVIL ENGINEERING is needed.

Appointments of Society Representatives

R. E. BAKENHUS, M. Am. Soc. C.E., has been reappointed one of the Society's representatives on the Engineers' Council for Professional Development for the term, October 1943 to October 1946.

ARTHUR S. TUTTLE, Past-President Am. Soc. C.E., has been reappointed one of the Society's representatives on the United Engineering Trustees, Inc., for the period, October 1943 to 1947.

E. B. WHITMAN, President Am. Soc. C.E., has been appointed one of the Society's representatives on the John Fritz Medal Board of Award for the four-year term, October 1943 to October 1947.

News of Local Sections

Scheduled Meetings

CENTRAL OHIO SECTION—Dinner meeting at Pomerene Hall on September 15, at 6:30 p.m.

CONNECTICUT SECTION—Dinner meeting at Hartford, Conn., late in September, at 6:15 p.m.

DAYTON SECTION—Luncheon meeting at the Engineers' Club on September 20, at 12:15 p.m.

NEW MEXICO SECTION—An address to be given at the University of New Mexico sometime in September (date open), at 7:30 p.m.

NORTHEASTERN SECTION—Dinner meeting at Northeastern University on September 22, at 6 p.m. (Annual Student Night sponsored by the Section jointly with Boston Soc. C.E.)

ST. LOUIS SECTION—Luncheon meeting at the York Hotel on September 27, at 12:15 p.m.

SEATTLE SECTION—Dinner meeting (place not announced) on September 27, at 6:15 p.m.

TENNESSEE VALLEY SECTION—Dinner meeting of the Knoxville Sub-Section at the S. and W. Cafeteria on September 14, at 5:45 p.m.

TEXAS SECTION—Luncheon meeting of the Dallas Branch at the Y.M.C.A. Club on September 6, at 12:15 p.m.; luncheon meeting of the Fort Worth Branch at the Blackstone Hotel on September 13, at 12 m.

Recent Activities

CONNECTICUT SECTION

This year only two members of the Yale University Student Chapter were able to be present at the Section's annual dinner for senior-class members of the Chapter, which took place in New Haven on May 14. The Section's prize of $10, awarded to the outstanding member of the senior class, went to Richard T. Richards. The presentation was made by Prof. C. W. Dunham, Faculty Adviser, who outlined the recent activities of the Student Chapter. Other guests were Ezra B. Whitman, President of the Society, and George T. Seabury, Secretary. Both discussed current problems and accomplishments of the Society. Charles R. Harte then gave a report on the strategic materials conference, held in Hartford on March 18, 1943. Recent developments in Connecticut, Mr. Harte said, are the establishment of a magnesium plant at East Canaan, the progress toward re-establishment of the iron-mining industry, and also the mining of substantial amounts of mica.

ILLINOIS SECTION

A joint luncheon meeting of the Section and the Chicago Engineers' Club took place on July 15. The feature of the occasion was a talk by Maj. Gen. Frank Parker, who discussed the parts played in our history by Washington, Jefferson, and Jackson—three presidents whom he considers great builders of America. General Parker, who had an important command in the first World War, also commented briefly on his experiences in France following the peace of Versailles.

NORTHWESTERN SECTION

On August 7 members of the Section, accompanied by local groups of the Founder Societies and the American Institute of Architects, journeyed to Rosemount, Minn., to visit the Gopher Ordnance Works. Transportation was by buses from the Twin Cities to Rosemount, where luncheon was served immediately upon arrival. Construction and operation of the various plants were explained to the group by Capt. J. O. Ackerman, of the Corps of Engineers, U.S. Army, and for many years a member of the Northwestern Section. Buses transported the party to the power stations, water-supply buildings, and manufacturing and storing units within the restricted area.

OREGON SECTION

On August 2 members of the Oregon Section entertained the post-convention group of Society officers and directors on tour of the Pacific Northwest. After an excellent dinner Director John W. Cunningham introduced the visitors. Mr. Holcomb, president of the Section, then called upon Society President Ezra B. Whitman, who spoke on recent developments in Society affairs. George T. Seabury, Secretary of the Society, then described the New York office of the Society and its method of handling Society business.

PANAMA SECTION

Over 125 attended the May meeting to hear Comdr. Miles P. DuVal present his solution for some of the navigation problems confronting the marine personnel of the Panama Canal. The lively discussion that followed his address was carried on largely by Panama Canal pilots and others acquainted with the existing conditions, and was confined to the navigational rather than the engineering aspects of the subject.

PHILADELPHIA SECTION

At its meeting held on July 8, the Philadelphia Section installed Howard T. Critchlow as president for the coming administrative year, and Lester L. Lessig and Lyle L. Jenne, as vice-presidents. Charles A. Howland will continue as secretary-treasurer. In the Student Chapter Essay Contest, it was announced that a prize consisting of entrance fee into the Society and one year's dues as Junior had been awarded to Richard H. Miller, of Drexel Institute, for his paper on flood control. The new officers were introduced by retiring President Adler, and President Critchlow also spoke briefly, asking for the cooperation of the Section members in the coming year. The speaker of the evening was Charles H. Topping, of the E. I. du Pont de Nemours Company, Wilmington, Del. Mr. Topping gave a highly interesting talk on his travels and engineering work in Persia, illustrating his remarks with several reels of moving pictures.

SACRAMENTO SECTION

The one-thousandth meeting of the Section, which was celebrated on June 15, was reported in a special item in the July issue of CIVIL ENGINEERING. At other weekly meetings in June, three members of the Section spoke from wide experience in special fields. On June 1 Fred Paget explained "niphometrology," the science of snow surveys, demonstrating the snow-sampling tube and scales by which the water-equivalent of snow cover is obtained directly. On June 8, A. G. Mott defined "Some Principles Underlying Engineering Valuation," from the standpoint of the taxing authority, particularly as to physical worth of public utilities. The speaker at the June 22d meeting was Martin H. Blote, water supervisor for the Sacramento and San Joaquin Rivers, who displayed the latest developments in current meters, and explained the necessity for precision measurements at 700 gaging stations to assure just distribution of water in this complex river system.

SAN DIEGO SECTION

Speakers at the June meeting of the San Diego Section were Maj. Bryan A. Burnett, retired Army officer, and Walter Thatcher. Major Burnett discussed various features of war construction work in Alaska and western Canada, while Mr. Thatcher spoke on vocational education, with special reference to the training of skilled workers for war industries.

SOUTH CAROLINA SECTION

On July 14 members of the South Carolina Section met at Columbia, S.C., for a joint session with the South Carolina Society of Engineers. Talks by the following comprised the technical program: F. E. Lawrence, director of the South Carolina State Planning Board; G. W. Svoboda, major, Corps of Engineers, U.S. Army, Fort Jackson, S.C.; R. M. Fowler, of the General Electric Company at Atlanta, Ga.; Samuel J. Mathis, lieutenant commander, Civil Engineering Corps, U.S. Naval Reserve, Washinton, D.C.; and N. W. Dougherty, Society Director and dean of engineering at the University of Tennessee.

TACOMA SECTION

The speaker of the evening at the June meeting of the Section —held in Olympia on the 15th—was Sheldon L. Glover, supervisor of the Division of Mines and Mining of the Department of Conservation and Development for the State of Washington. Mr. Glover's subject was "The Mines and Minerals of the State of Washington." Others who spoke were John W. Cunningham, Society Director, who reported recent activities of the Board of Direction; and E. L. Warner, who read a short article, entitled "Time to Think," which appeared in a recent issue of the *Tennessee Valley Engineer*. The article supplemented Mr. Warner's talk to the Section at the March meeting.

TEXAS SECTION

On June 14 members of the Fort Worth Branch of the Texas Section heard Capt. D. W. Gray, of the U.S. Engineer Office at Fort Worth. Captain Gray advised that the Corps of Engineers is still accepting enlistments from certain qualified men prior to their induction and requested all members to be on the look-out for any men so qualified. At the July meeting of the Fort Worth Branch, C. J. Elliot discussed the postwar planning program, which is being carried on by the Public Roads Administration in cooperation with the various state highway departments. Mr. Elliot is district engineer for the Public Roads Administration.

Not the "Parent Society"

A TENDENCY has been noted frequently, on the part of individual members as well as of Local Sections, to speak of the organization as a whole as the "parent Society." Officers of the Society, particularly Board members, deprecate this wording. They urge that better and more appropriate terms are available.

Doubtless reference to a "parent" organization seems a happy one to many people. Certainly the word is intended to imply a relationship of responsible and dutiful obligation. The thought is to build up the main organization to its proper position of importance and to emphasize the subordinate rôle of its parts.

No quarrel can be had with this ideal. However, the fact remains that the term is inaccurate, and it is undignified—a sort of pseudonym for what is really a time-honored and respected true name. Furthermore, the term implies that there are other societies within the same family, instead of just one organization.

Erring at the other extreme is the habit of some members, particularly those of the older groups, who speak affectionately of the "American Society." This term reflects a deep pride and there was perhaps ample reason for its use many years ago. But today, when there are other "American" societies, whose members are also jealous of their fine reputations, this use is easily misunderstood. It is one of those well-intended designations—a sort of nickname—which should seldom be used, and then only within the confines of the "family."

What a Whale of a Difference a Half Inch Makes!

YES, that fraction of an inch off the length and width of CIVIL ENGINEERING has cut by almost 10% the paper stock used in each copy. Thus the reduction in use of paper required by the War Production Board can be met without a furthur reduction in editorial content or restricting the number of copies printed.

Now that it is thus possible to increase the issue to meet minimum demands, it will no longer be necessary for subscribers to return extra copies as requested in the May 1943 issue of CIVIL ENGINEERING. Response to this plea revealed the generosity and thoughtfulness of Society members who, in returning their copies, made it possible to fill all requests. Many thanks are extended for this cooperation in returning several hundred copies.

The new over-all size of $8^1/_8$ by $11^1/_4$ in. has been accomplished by trimming the margin only. (See "CIVIL ENGINEERING Cuts Its Coat to Fit," page 289 of the June 1943 issue.) No changes in type face, type size, or arrangement have resulted. All twelve numbers of volume 13 can be bound together as in past years if desired, although the few bleed cuts in the right-hand margins will suffer somewhat in the trimming process.

ITEMS OF INTEREST

About Engineers and Engineering

Army Commissions for Civil Engineers

A LIMITED number of Army commissions are still available for civil engineers with training and experience, as detailed below, qualifying them as either Sanitary Engineers, Construction Contract Renegotiators, Construction Equipment Maintenance Engineers, Supervisors of Marine Construction, Highway Engineers, or Heavy Construction Engineers.

The Officer Procurement Service, the sole procurement agency for officers from civil life for all branches of the Army, will provide necessary information at its field branch offices to all individuals who are interested in making a direct contribution to the war effort and who believe themselves qualified in any of the following capacities:

Sanitary Engineer: Applicant must have a baccalaureate degree in civil, sanitary, or chemical engineering, plus two years of experience; or a master's degree, plus one year of experience. Experience must have been acquired in at least one of the following activities: mosquito control, rodent control, water supply and treatment, or sewage treatment. There is no minimum age; the maximum is 45. Men qualified for limited service are acceptable. Grades available are Second Lieutenant, First Lieutenant, and Captain.

Construction Contract Renegotiator: Applicant must be a college graduate or the equivalent through self-education and business experience. Must have a minimum of ten years of recent administrative experience as a construction contractor, architect, or engineer, subsequent to additional experience as an actual supervisor of construction. Candidates must have had contract-drawing experience at a level commensurate with the proposed assignment of the renegotiation of large Government contracts. There is no minimum age; the maximum is 55. Men qualified for limited service are acceptable. Grades available are Major and Lieutenant Colonel.

Construction Equipment Maintenance Engineer: Applicant must be a high school graduate. Must have five years of experience as a supervisor of the maintenance of earth-moving equipment such as tractors, bulldozers, draglines, and power shovels. Applicant must be physically qualified for general military service. Grades available are Second Lieutenant, First Lieutenant, and Captain.

Supervisor of Marine Construction: Applicant must be a high school graduate. Must have had five years' recent experience as a supervisor of construction and repair of waterfront facilities for loading, unloading, and storage, including reinforced concrete piers, docks, and warehouses. There is no minimum age; the maximum is 48. Applicant must be physically qualified for general military service. Grades available are Captain and Major.

Highway Engineer: Applicant must have a degree in civil engineering or an equivalent combination of training and experience. Must have had five years of recent experience as a direct, on-the-job supervisor of construction of roads and highways. (NOTE: Designing, office management, inspection, and indirect supervision of construction are not the type of experience desired.) There is no minimum age; the maximum is 55. However, men over 45 must be outstanding. Applicant must be qualified for general military service. Grades available are First Lieutenant, Captain, Major and Lieutenant Colonel.

Heavy Construction Engineer: Applicant must be a high school graduate. Must have had five years' experience in the direct supervision of heavy construction projects involving reinforced concrete, masonry, and heavy timberwork, such as warehouses, shops, and ordnance plants. There is no minimum age; the maximum is 55. Applicant must be qualified for general military service. Grades available are First Lieutenant, Captain, Major, and Lieutenant Colonel.

Field branch offices of the Officer Procurement Service are located in Boston, Hartford, New York City, Albany, Buffalo, Syracuse, Baltimore, Philadelphia, Pittsburgh, Richmond, Atlanta, Birmingham, Nashville, Charlotte, Columbus, Cleveland, Indianapolis, Cincinnati, Louisville, Chicago, Detroit, Milwaukee, Omaha, Denver, Kansas City, Minneapolis, St. Louis, Dallas, San Antonio, Houston, New Orleans, Salt Lake City, Oklahoma City, Los Angeles, San Francisco, Portland, and Seattle.

Working Stresses of Lumber and Fastenings Increased by WPB

WORKING stresses for all lumber which has been graded for strength by a recognized lumber grading agency have been increased 20% by War Production Board Directive No. 29, effective August 9, 1943. Increased stresses in the design of timber joints, using timber connectors, bolts, lag screws, nails, drift pins, and wood screws, are also authorized.

An estimated 200,000,000 fbm of structural lumber and 2,000 tons of metal fastenings will be made available annually by this action, as noted in "National Emergency Specifications for the Design, Fabrication and Erection of Stress Grade Lumber and Its Fastenings for Buildings." These specifications govern the use of stress grade timber and fastenings for all buildings constructed, financed, or approved by governmental agencies on contracts placed after November 1, 1943. These agencies are empowered to put the directive into immediate effect wherever possible.

Where contracts already have been placed or will be placed before November 1, it is directed that they should be reviewed promptly and changes made to comply with the emergency specifications unless this is not feasible. These specifications do not cover dwelling houses and light framing in which dimension lumber rather than structural is used almost exclusively. Neither do they prevent the use of higher stresses in military construction where such stresses are specified by the military authorities. As in the cases of Directives 8 and 9, covering steel and concrete, respectively, Directive No. 29 is limited to buildings in which stress grades of lumber are used, because during the emergency such buildings are largely financed directly or indirectly by the government. The previous revisions covering steel were noted in the December 1942 issue of CIVIL ENGINEERING.

In this single document is given the information now scattered in a number of publications and some data resulting from recent tests not yet published. The document covers not only working stresses for structural grades of lumber and design loads and formulas, but timber connector, bolt, lag screw, nail, spike, drift pin, and wood screw joints. In addition a chapter on glued laminated structural lumber contains general provisions, intended to assure satisfactory fabrication and construction in that comparatively new field of lumber construction.

These specifications were prepared under the general direction of Howard Coonley, director, Conservation Division, and C. L. Warwick, Assoc. M. Am. Soc. C.E., chief, Materials Branch, Conservation Division. Their development has been the special assignment of R. P. A. Johnson, wood consultant, and C. A. Willson, M. Am. Soc. C.E., chief, Construction Materials Section. L. J. Markwardt, M. Am. Soc. C.E., chief, Timber Mechanics Section, and other staff members of the U.S. Forest Products Laboratory, Madison, Wis., were consulted freely on many of the technical details and concurred in the decisions made. Experience and practices of the Army, Navy, and other government departments were made available and afforded essential background for the analysis underlying the conclusions drawn.

The Technical Advisory Committee of the National Lumber Manufacturers Association and affiliated associations in the lumber industry provided access to all their pertinent data through the cooperation of Francis J. Hanrahan, Assoc. M. Am. Soc. C.E., and Richard G. Kimbell, Affiliate, Am. Soc. C.E. Copies of the specifications are being printed now and should be available about October 1. Requests should be sent to the Distribu-

tion Planning Unit, War Production Board, Room 1090, Railroad Retirement Building, Washington 25, D.C.

Engineers with Training in Physics Needed for War Research and Teaching

THE heaviest demands for research workers and teachers made upon the Office of Scientific Personnel of the National Research Council are in the field of physics. The supply of persons whose chief training has been in this field is exhausted, and persons who can do the work of physicists, either in war research or in teaching, must be sought from other fields. There are large numbers of persons in other fields whose scientific and technical training includes sufficient physics for them to do work ordinarily requiring physicists. Several hundred such persons are already substituting for physicists in research and in teaching, and several hundred more are needed.

All persons who feel that they may be able to serve in this capacity, either in research or as teachers of beginning physics in the training programs of the armed forces, should communicate at once with Dr. Homer L. Dodge, director of the Office of Scientific Personnel, National Research Council, 2101 Constitution Avenue, N.W., Washington 25, D.C.

Brief Notes

THE esteem in which Society publications are held by the members is attested by a letter, written by the mother of a young member and recently received at Society Headquarters. The letter states that the son, a Junior in the Society and first lieutenant in the Corps of Engineers, U.S. Army, though a prisoner of the Germans, makes the special request that his subscription to CIVIL ENGINEERING and PROCEEDINGS be renewed.

* * * *

THE War Department has announced the availability of a new book of "Hydraulic Tables." This volume—prepared under the direction of the U. S. Chief of Engineers by the Mathematical Tables Project of the Works Projects Administration for the City of New York—contains forty-six tables especially applicable to the solution of the problems of open channel flow. Copies may be obtained from the Superintendent of Documents, Washington, D.C., at $1 a copy.

* * * *

RECENT publications of the Engineering Experiment Station at Iowa State College include Bulletin 159, entitled "The Percentage Stress-Strain Diagram as an Index to the Comparative Behavior of Materials Under Load." The booklet presents an extensive comparison of the conventional and percentage stress-strain diagrams for many engineering materials, and a percentage technique for study and comparison of shape of stress-strain diagrams, both qualitatively and quantitatively. It may be obtained without charge from Iowa State College, Ames, Iowa.

* * *

IN a recent radio broadcast on "Building for War," Anthony Hoadley, president of the Mohawk–Hudson Section, pointed out that much of the construction being done in connection with the war program calls for the services of the civil engineer.

* * * *

THREE undergraduate scholarships for engineering students have been established at the University of Wisconsin by the John Morse Memorial Foundation. Each of these scholarships will aid deserving students with $500 during the school year. Established by Col. R. H. Morse, president of Fairbanks, Morse and Company, in memory of his son, John Morse, the Foundation is aiding worthy educational, scientific, and medical enterprises.

* * * *

AT the twelfth annual meeting of the Producers' Council, held in Cincinnati on May 25 and 26, the responsibility of the construction industry to provide postwar plans was stressed. The Society's representative at the meeting—J. E. Root, M. Am. Soc. C.E.—reported that the integration of private and public construction was the concern of the conference.

* * * *

ANNOUNCEMENT has been made of the eleventh annual meeting of the Engineers' Council for Professional Development, which will take place in the Board Room of the American Society of Civil Engineers, 33 West 39th Street, New York, on October 23 at 9:30 a.m. A meeting of the Executive Committee—on Friday, October 22—will precede the meeting proper.

Hail to the Concrete Inspector!

Who takes all the raps and the buffets and blame
When the work and the "specs" are not quite the same?
Who carries the load of the public protector?
It's the wirey hard-bitten old concrete inspector!

The work must be perfect from digging to dome
And each operation recorded in tome.
Materials, workmanship must be correct or
Woe unto him—the concrete inspector!

Up early at morning, with flashlight at night,
He tests and he pests and he keeps up the fight.
He interprets the thoughts of the brass-hat director,
He checks and he rejects—the concrete inspector!

Oh give me a man who has patience and tact,
With a keen sense of sight and a bone in his back,
Who can get the job done and of none is respecter,
And I'll make him immortal—that concrete inspector!

—J. W. KELLY

Cooper Union Curtails Civilian Training

THE first major curtailment of civilian training in the engineering schools of the country has been announced by Cooper Union. Since June 14, only freshman engineering courses have been offered in the day school of new civilian students, who will be admitted only in limited numbers, according to Dean George F. Bateman.

The draft situation, in addition to the need for making room for the military program, has led to the adoption of this new policy. Women students and 4F men are not sufficiently numerous to warrant the provision of instruction in the day school beyond the first year. The night school will continue to function as usual.

National Safety Congress to Meet

SAFE transportation in wartime will be the keynote of discussion when traffic leaders meet in Chicago, October 5–7, for the National Safety Congress. The traffic sessions will get under way Tuesday afternoon, October 5, and that evening the role of women in transportation will be discussed at a joint meeting of the Street and Highway Traffic Section, the Commercial Vehicle Section, and the Institute of Traffic Engineers.

Army and Navy officials, representatives of transit companies, and operators of fleets of commercial vehicles will get together October 6 to consider the problems of transporting America's growing army of industrial workers to and from their jobs and of expediting the movement of war cargoes. ODT policies on war traffic control, fact-finding studies for improving war transportation, and rerouting and rescheduling mass transportation will be considered on October 7. The traffic sessions will end with a general meeting, at which the leading address will be the Army's contribution to traffic safety.

The Congress is sponsored by the National Safety Council.

Engineering Digest Published for Distribution in China

PUBLICATION of the "Universal Engineering Digest" for distribution in China commenced with the April issue. To fulfill the need for technical and scientific journals, which cannot be sent into China while the Burma Road is closed, the Digest will record important technical developments as well as general industrial news. Bible paper is used so that the resulting light copies can be flown into the beleaguered nation.

Publication was undertaken by the Universal Trading Corporation which is the official purchasing agency for the Chinese Government in the United States. The publisher welcomes contributions of general industrial news, abstracts of technical articles, special articles dealing with specific problems, and statistical data of general interest. Its aim is to keep the engineer and industrial executives of China informed of important technical developments in the United States. The publication office is located at 630 Fifth Avenue, New York 20, N.Y.

N. G. Neare's Column

Conducted by

R. ROBINSON ROWE, M. AM. SOC. C.E.

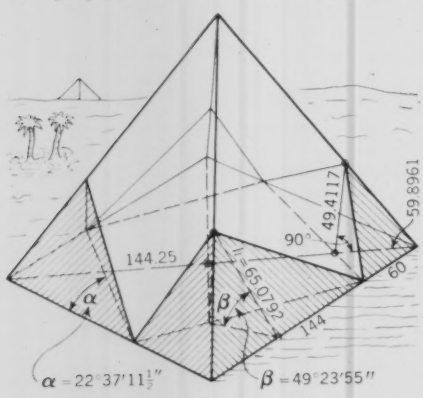
"PYRAMIDS," lectured Professor Neare, "are at once among the oldest and the greatest works of engineers. Deriving its name from 'fireplace' when it had supported the 'open hearth' for sacrifices, the pyramid became the greatest of mausoleums in ancient times. Medieval geometers idealized its form, and modern idealists liken its shape to a nation's economic structure, resting on a base of forgotten men.

"We are studying tonite an old mausoleum humbled by the camoufleur. If its square base 204 pics on a side was made to appear an inscribed square 156 pics on a side, how much did the camouflage rotate the base?"

"No puzzle to that!" scoffed Cal Klater. 'You had framed the problem so that the right triangles between the two squares had legs of 60 and 144 ft and an angle of $\cot^{-1} 2.4$, or $22° 37' +$."

"So far, so good," conceded the Professor. "The height being 119 pics, did you also find the area painted?"

"Yes, altho I nearly fell into your trap by figuring the area of the new square base projected on the faces of the pyramid.



Of course, the area painted was all but that, consisting of four little and four large triangles, as shown on the accompanying sketch. With persistent trigonometry, I found:

Area of small triangles.....	7,809.5
Area of large triangles.....	18,742.8
Total area painted.....	26,552.3

"I check his answer," added Ken Bridgewater, "but I used the simpler Bridgewater Method. Since all faces have the same slope of 6 horizontal to 7 vertical, the painted area will be to the horizontal projection as $\sqrt{85}$ is to 6—so that the painted area is $2{,}880\sqrt{85}$. Incidentally, I noted that you had framed the pyramid so that the length of the inclined edges was an even 187 pics, but I didn't see why."

"All part of a deep plot," replied the Professor. "By diverting the attention of you expert geometricians toward geometric perfections, you were led to the inference that this was a geometric pyramid. Originally, and again after restoration, the pyramids of Egypt were built of platforms, each smaller than the one below. Since only the horizontal faces of the exposed margins of the platforms had to be painted, the correct answer must be 17,280 sq pics, the number being simply $204^2 - 156^2$.

"For a new problem, here's one guaranteed to be free from snares, yet an estimator spent the best part of a day on it. A cylindrical pier 6 ft in diameter was cast of solid concrete, except for a cylindrical hole left for a sewer main. The hole had a diameter of 4 ft and its axis intersected the pier axis at an angle of 30°. What volume should the estimator deduct from gross pier volume because of the hole?"

[*Although Professor Neare disagrees with Cal Klater for once, he admits that pyramidography is not commonly included in engineering curricula. Accordingly he acknowledges as able Cal Klaters, Richard Jenney, Arthur E. Elliott (who drew the sketch), Robert W. Woodbury, Byron A. Bledsoe, and James R. Bole. The new problem hails from Alliance Army Air Base, where Major Mansfield proposed it to the Professor's son.*]

NEWS OF ENGINEERS

Personal Items About Society Members

GEORGE W. BURPEE, a partner in the New York engineering firm of Coverdale and Colpitts, has been elected president of the General Aniline and Film Corporation, with offices in New York. Mr. Burpee is a Director of the Society.

C. HAROLD LOUREE has been appointed district manager of the New Orleans (La.) sales office of the Ingalls Iron Works Company. He was previously designing engineer for the Austin Company at Oklahoma City, Okla.

CHARLES E. NICHOLS has resigned from the Tennessee Valley Authority, with which he has been associated in Knoxville, Tenn., and Washington, D.C., since 1937, in order to take charge of the Washington office of the American Warehousemen's Association, Merchandise Division.

BENJAMIN A. MORGAN, JR., was recently promoted from the rank of first lieutenant in the Coast Artillery Antiaircraft to that of captain. At present he is stationed at Paterson, N.J. Before receiving his commission Mr. Morgan was resident engineer for J. E. Sirrine and Company, of Greenville, S.C.

A. L. ALIN, who is in the U.S. Engineer Office, has been transferred from the Denison (Tex.) District Office, of which he was head, to the Omaha (Nebr.) District.

T. S. LOVE, formerly resident engineer for Haile and McClendon, of Houston, Tex., is now a second lieutenant in the Corps of Engineers, U.S. Army, stationed at Camp Claiborne, La.

GORDON L. BURT has been granted a leave of absence from his position as resident engineer for Charles H. Hurd, consulting engineer of Indianapolis, Ind., in order to join the civil engineering faculty at Rose Polytechnic Institute for the duration of the Army Specialized Training Program.

PAUL C. GILLETTE is now a lieutenant commander in the Civil Engineering Corps of the U. S. Naval Reserve, stationed at the Bureau of Yards and Docks in Washington, D.C. Prior to receiving his commission early this year, Commander Gillette was an engineer for the Bureau of Internal Revenue in New York.

J. T. L. MCNEW, head of the civil engineering department at the Agricultural and Mechanical College of Texas, has been commissioned a major in the Corps of Engineers, U.S. Army. C. E. SANDSTEDT, professor of civil engineering, will be acting head of the department during Professor McNew's absence.

HENRY A. YANCEY recently resigned as city manager of Durham, N.C., in order to accept a similar post at Greensboro, N.C. Mr. Yancey has been city manager at Durham since 1935.

FRANCIS J. PERNA has just been promoted from the rank of lieutenant in the U.S. Army to that of captain. Mr. Perna is plans and training officer of the 52d Engineer Combat Battalion at Camp Butner, N.C.

CHARLES H. BUCKIUS, assistant to the Secretary of Highways for the Pennsylvania State Department of Highways at Harrisburg, Pa., has been made chief engineer of the Department.

ANDREW M. KOMORA has left the Tennessee Valley Authority in order to accept a position as assistant engineer-director on the Central Hidro-electrica del Canon del Pato Project on the Rio Santa in Peru. Mr. Komora has recently been in charge of installing additional generating units at Wheeler, Wilson, and Pickwick dams of the TVA.

F. E. GIESEN, assistant supervising engineer for the Defense Plant Corporation on construction work near Hot Springs, Ark., has been commissioned a lieutenant in the Civil Engineering Corps of the U.S. Naval Reserve and ordered to report at Williamsburg, Va.

HAROLD A. RANDS, senior hydroelectric engineer for the U.S. Engineer Office at Portland, Ore., is retiring after many years of service with the U.S. Corps of Engineers.

JOHN C. PAGE has resigned as U.S. Commissioner of Reclamation because of poor health, though he will remain in government service in the capacity of a consulting engineer. For some months HARRY W. BASHORE has been serving as acting commissioner.

CARROLL L. MANN, JR., major, Corps of Engineers, U.S. Army, has been transferred from Fort Bragg, N.C., to Wilmington, N.C., where he will assume duties as executive officer of the Wilmington District Engineer Office.

THEODORE L. CONDRON and CHESTER L. POST have, by mutual consent, dissolved their engineering partnership in Chicago, which was formed in 1924. For the past several years Mr. Condron has been in charge of the active practice of the firm, while Mr. Post has been located in Washington, D.C., as chairman of the Advisory Committee on Engineering of the Public Buildings Administration, Federal Works Agency.

SIGVALD JOHANNESSON, designing engineer for the New Jersey State Highway Department, has been appointed head of a highway planning bureau, recently created in New Jersey for greater efficiency in dealing with road problems, especially in the postwar period.

DECEASED

JOHN WATSON ALVORD (M. '93) retired consultant of Chicago, Ill., and Honorary Member of the Society, died at his summer home at Douglas, Mich., on July 31, 1943. He was 82. A biographical sketch and photograph of Mr. Alvord appear in the Society Affairs section of this issue.

ARTHUR BONIFACE (Assoc. M. '10) village engineer of Scarsdale, N.Y., died at his home there on July 18, 1942, at the age of 64. Born and educated in England, Mr. Boniface came to this country in 1901. For some years he was with the Interborough Rapid Transit Company on subway construction, serving as engineer in charge of the construction of certain sections of the Seventh Avenue subway. He had been village engineer of Scarsdale since 1922 and, for the past two years, was also village manager.

DALTON MUNROE BROWN (Assoc. M. '33) of New York City, N.Y., died on May 16, 1943, at the age of 43. For some years (1928 to 1937) Mr. Brown was with the Marcus Contracting Company, of New York, on the construction of the Eighth Avenue Subway. He then became connected with Spencer, White and Prentis, of New York, and more recently was with Dry Dock Associates at Portsmouth, Va.

ARTHUR CASSIDY EVERHAM (M. '12) since 1940 Director of Public Works for Kansas City, Mo., was fatally injured in an automobile accident on July 22, 1943. Mr. Everham, who was 65, spent his early career in railroad work, having been assistant tunnel engineer for the Michigan Central Railroad on the construction of the Detroit River Tunnel. From 1919 to 1939 he was with the Raymond Concrete Pile Company—for part of this period as Western sales manager. During the first World War Mr. Everham served as a major in the Construction Division of the U.S. Army.

JAMES RAYMOND HEAD (Assoc. M. '32) district sales engineer for the California Corrugated Culvert Company at Berkeley, Calif., died at his home at Chico, Calif., on July 19, 1943. Mr. Head, who was 56, had been with the Arizona Power Company, and from 1919 to 1929 was with Polk and Robinson, of Chico, on municipal, irrigation, and drainage work. He was also city engineer of Chico. He had been with the California Corrugated Culvert Company since 1935.

RUSSELL MELVIN OBERT (Assoc. M. '34) assistant engineer for the Columbia Engineering Corporation at Columbus, Ohio, died in that city on June 5, 1943. Mr. Obert, who was 41, had been with the Columbia Engineering Corporation since 1928—on valuation work for various utility companies in Ohio, Pennsylvania, West Virginia, and Kentucky.

AARON ISRAEL RAISMAN (M. '24) retired chief designing engineer of the New York City Board of Transportation, died at his home at Kew Gardens (Queens), N.Y., on July 11, 1943. He was 69. Except for two years in railroad work, Mr. Raisman's entire career was spent in the planning and design of rapid transit subways. Entering the employ of the Rapid Transit Railroad Commission in 1900, Mr. Raisman was (from 1924 until his retirement in 1938) in charge of the design of the Independent Division of the New York City Transit System. He was responsible for many of the improvements in the subway plans.

GEORGE CHEEVER SCHERER (Affiliate '11) of Beaufort, N.C., died June 7, 1943, at the age of 73. Beginning in 1898, Mr. Scherer spent his career with the U.S. War Department, being located in U.S. Engineer Offices in various parts of the country. He retired recently.

CHARLES MILLS SLOCUM (M. '97) retired engineer of Springfield, Mass., died recently. He was 89. From 1876 to 1886 Mr. Slocum was principal assistant to the city engineer of Springfield. In the latter year he was elected city engineer, continuing in that capacity until his retirement in 1940.

ROBERT SPURR WESTON (M. '11), consulting engineer of Boston, Mass., died recently at Wakefield, R.I., at the age of 74. Mr. Weston had maintained a private practice with offices in Boston since 1899—since 1912 under the name of Weston and Sampson. Coincidentally, for part of this period (1912 to 1916), he was assistant professor of public health engineering at Massachusetts Institute of Technology. He had served numerous states, municipalities, and corporations on problems of water supply, stream pollution, and sewage and industrial waste treatment.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From July 10 to August 9, 1943, Inclusive

ADDITIONS TO MEMBERSHIP

ISENBERG, BERNARD PAUL (Jun. '43), Junior Engr., Brewster Aeronautical Corp., Hatboro, Pa. (Res., 322 Central Park West, New York 25, N.Y.)

BABCOCK, JOHN ORLO (Jun. '43), Junior Engr., Airplane Div., Curtiss-Wright Corp. (Res., Y.M.C.A., Room 544), Columbus, Ohio.

BARCLAY, JAMES WALLACE (Assoc. M. '43), Senior Engr., U.S. Engrs., Army Post Office 858, Care, Postmaster, Presque Isle, Me. (Res., 725 South West 24th Rd., Miami 36, Fla.)

BARCO, VIRGILIO (Jun. '43), Ingeniero Jefe de Obras de Fomento, Municipal Departamento de Santander del Norte, Carrera 4a #10-53, Cucuta, Colombia.

BARRON, REGINALD ARNOLD (Jun. '43), Asst. Engr., Dist. Soil Laboratory, U.S. Engr. Dept., 166 Doyle Ave. (Res., 40 Sessions St.), Providence, R.I.

BARTON, ROBERT MCCLURE (Jun. '43), Technical Writer, Service Eng., Douglas Aircraft Co., El Segundo (Res., 515 West Lime St., Inglewood), Calif.

BAUML, JOSEPH ANTHONY (Jun. '43), 2d Lt., Corps of Engrs., U.S. Army, 614 Barbee St., San Antonio, Tex.

BEARD, FRANK WENDELL (Assoc. M. '43), 2d Lt., San. Corps, U.S. Army, Box 15, Newcastle, Tex.

TOTAL MEMBERSHIP AS OF AUGUST 9, 1943	
Members	5,972
Associate Members	7,272
Corporate Members	13,244
Honorary Members	32
Juniors	5,693
Affiliates	74
Fellows	1
Total	19,044
(Total August 10, 1942	17,933)

BEATTY, ROYCE EDWARDS (Jun. '43), Structures. Engr., Aircraft, Structural Control Dept., 1053 Lititz Ave., Lancaster, Pa.

BENSON, WILLIAM CHARLES, JR. (Jun. '43), Plant Layout Engr., Bendix Aviation Corp., Teterboro (Res., 170 South Clinton St., East Orange), N.J.

BOOSS, GEORGE FREDERICK (M. '43), Civ. Engr., Ebasco Services, Inc., 2 Rector St., New York, N.Y. (Res., 27 Bellevue, Summit, N.J.)

BOYER, PETER BOYAJIAN (Assoc. M. '43), Associate Engr. (Hydraulics), U.S. Army Engr., 202 Pittock Block, Portland, Ore.

BOYNTON, JERALD H. (Jun. '43), 2d Lt., U.S. Army, 2245 Learnard, Lawrence, Kans.

BUTTS, STEPHEN DECATUR (M. '43), Civ. Engr. and Project Mgr., O. W. Burke Co., 1101 Fisher Bldg., Detroit, Mich.

CAREY, WILLIAM NELSON, JR. (Assoc. M. '43), Maj., Corps of Engrs., U.S. Army, U.S. Engr. Dept., Box 4970, Jacksonville, Fla.

CARUSO, VITO (Jun. '43), Junior Engr., Curtiss-Wright Airplane Corp., Airport Plant, Buffalo, N.Y. (Res., 1378 Springfield Ave., Irvington, N.J.)

COHN, HAROLD PAUL (Jun. '43), Junior Stress Analyst, The Glenn L. Martin Co., Middle River (Res., 4636 Walther Blvd., Baltimore 14), Md.

COLLINS, ALFRED STUART (M. '43), Cons. Engr., 232 Delaware Ave., Buffalo 2, N.Y.

CORDLE, THOMAS LLEWELLIN (Assoc. M. '43), Lt. (jg), O-V (S), U.S.N.R., 2726 Willow Drive, Charlotte 4, N.C.

CUTLER, ROBERT ROSCOE, JR. (Jun. '42), 2d Lt., U.S. Army, Riverview Pl., Washington, Mo.

DABNEY, JAMES LAWRENCE (Jun. '43), Engr. Aide, Office Engrs. Office, Kaiser Co., Inc., Bwan Island, Portland, Ore.

DE SALIGNAC, LOUIS LEON (M. '43), Chf. Engr., Pan Am. Petroleum Corp., 944 St. Charles Ave., New Orleans, La.

DIEHL, OLIVER CHARLES (M. '43), Erecting Engr., Am. Bridge Co., 1621 Frick Bldg., Pittsburgh, Pa.

DOUGLAS, CLARENCE JOSEPH (Assoc. M. '43), Lt. Col., Corps of Engrs., U.S. Army, Headquarters, Camp Abbot, Ore.

EISENBERG, EUGENE ROBERT (Jun. '43), Ensign, U.S.N.R., Care, Smith, 969 East California St., Pasadena 5, Calif.

ERICSON, EVERT ERIC (Jun. '43), Civ. Engr., Myers & Noyes, 303 Furman Bldg. (Res., 435 Clifford St.), Corpus Christi, Tex.

FEHRMAN, ROLLIE GREGG (Jun. '43), Research Engr. and Director, Civ. Aeronautics Research Project, Univ. of Missouri, Columbia, Mo.

FEILD, JAMES WYATT (M. '43), San. Engr., Office, Chf. of Engrs., War Dept., 23d and C Sts., Washington, D.C. (Res., 3314 Alabama Ave., Alexandria, Va.)

FENSTER, CHARLES ALBERT (Jun. '43), Draftsman, Read-York, Inc., 5th Ave. and 56th St. (Res., 720 Fifty-Ninth Pl.), Kenosha, Wis.

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FLEMING, JULIAN ROANE (Jun. '43), Asst. Prof., Hydr. and San. Eng., Univ. of Tennessee, Ferris Hall, Knoxville, Tenn.

FORD, PAUL JOSEPH (Assoc. M. '43), Chf. Building Insp., Prack & Prack and The Chester Engrs., Rubber Synthesis Plant, Point Neches, Tex.

FOWLER, KEITH TRACY (Jun. '43), Engr., Douglas Aircraft Co., Santa Monica (Res., 3539½ South Flower, Los Angeles 7), Calif.

GEIS, FREDERICK LOUIS, JR. (M. '43), Chf. of Operations, 3d Locks Constr., Special Eng. Div., The Panama Canal, Diablo Heights, Canal Zone.

GOODRICH, HENRY CALVIN (Jun. '43), Ensign, CEC, U.S.N.R., 204 West Washington St., Fayetteville, Tenn.

GRAVES, WILLIAM EDWARD (Jun. '43), Private, Corps of Engrs., U.S. Army, 6518 North Rockwell, Chicago, Ill.

HACKENBROCH, JOHN PETER (Jun. '43), Structural Draftsman, Anaconda Copper Mining Co., 25 Broadway, New York, N.Y. (Res., Fiat Ave., Iselin, N.J.)

HADDEN, SAMUEL CORNELIUS (M. '43), Chairman, State Highway Comm., State House Annex (Res., 322 East 47th St.), Indianapolis, Ind.

HARBAUGH, YOST DANIEL (Assoc. M. '43), Constr. Engr., Sewer Div., U.S. Govt., District Bldg. (Res., 1617 Monroe St., N.W.), Washington 10, D.C.

HARTWELL, JAMES HAYWOOD (Jun. '43), Asst. Hydr. Engr., U.S. Geological Survey, 945 Post Office Bldg., Boston 9 (Res., 36 Cresent Ave., Melrose), Mass.

HAWKER, CLARENCE ROBERT (Jun. '43), Asst. Design Engr., City of Tacoma, City Hall Annex (Res., 6839 South Puget Sound), Tacoma, Wash.

HEILMAN, LUTHER JAMES (Jun. '43), 2d Lt., Corps of Engrs., U.S. Army, Administrative Officer, 32d Battalion, Company C, Engr., Replacement Training Center, Fort Leonard Wood, Mo.

HEWITT, CLYDE BURTON, JR. (Jun. '42), Capt., Corps of Engrs., U.S. Army, 604th Engr. Camouflage Battalion, Camp Campbell, Ky.

HILDINGER, JOHN ROSS (Jun. '43), Ensign, CEC, U.S.N.R., 310 South Division St., Ann Arbor, Mich.

HIMELRIGHT, LORING KENNETH (Jun. '43), Asst. Prof., Civ. Eng., The Citadel (Res., 646-D Rutledge Ave.), Charleston, S.C.

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KOO, HAI-CHANG BENJAMIN (Jun. '43), Junior Engr., Rust Eng. Co., Clark Bldg. (Res., Y.M.C.A., Wood St.), Pittsburgh, Pa.

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NEW, JOHN CALHOUN (Jun. '43), Care, Civ. Eng. Dept., Univ. of Missouri, Columbia, Mo.

NOVICK, SIDNEY (Jun. '43), Junior Material Engr., Navy Yard, Brooklyn (Res., 269 East Broadway, New York 2), N.Y.

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SCHARDER, RAYMOND AUGUSTUS (Assoc. M. '43), Lt. (jg), U.S.N.R., 103d Constr. Battalion, Davisville, R.I.

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STEYER, CLARK (Assoc. M. '43), Asst. Div. Engr., State Highway Comm. (Res., 504 South Central), Chanute, Kans.

SULLINS, ROBERT TIMOTHY, JR. (Jun. '43), Stress Analyst and Designer, Consolidated-Vultee Aircraft Corp. (Res., 1436 Eighth Ave.), Fort Worth 4, Tex.

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TILDEN, NORMAN EDGAR (Jun. '43), 605 West Grant St., Blair, Nebr.

WALLACE, CLARK EDWARD (Assoc. M. '43), Asst. Secy. and Office Mgr., Tuller Constr. Co., 95 Monmouth St. (Res., 61 Crest Drive), Red Bank, N.J.

WEBB, WILLIAM BRENARD (Assoc. M. '43), Section Head, Underground Utilities, U.S. Engr. Dept., Denison, Tex.

WEBER, ERIC THOMAS (Jun. '43), 873 Eastern Parkway, Louisville 4, Ky.

WEBSTER, WILLIAM STEPHEN, JR. (Jun. '43), Ensign, U.S.N.R., 30 Cleveland St., Wakefield, R.I.

WENTHE, ALBERT WILLIAM (M. '43), Treas., Fruin Colnon Cont. Co., 502 Merchants Laclede Bldg., St. Louis, Mo.

WHITE, PORTER J. (Jun. '43), Associate Structural Engr., Public Works Drafting Room, Navy Yard, Mare Island (Res., 76 Kempff St., Vallejo), Calif.

WININGER, EDWARD (M. '43), Pres., The Nicholson Co., Inc., 10 Rockefeller Plaza, New York 20, N.Y.

WINSCH, CHARLES EMIL (Jun. '43), Lt. (jg), U.S.N.R., 876 Islington St., Portsmouth, N.H.

WITHEY, WILLIAM HENRY (Jun. '43), Junior Structures Engr., Airplane Div., Curtiss-Wright Corp., Airport Plant, Buffalo (Res., 110 Mill St., Williamsville), N.Y.

WOODBURN, CHESTER CHARLES (M. '43), (Dougher, Rich & Woodburn), 310 Old Colony Bldg. (Res., 1410 Forestdale Drive), Des Moines, Iowa.